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THE RIGHT HONOURABLE SIDNEY HERBERT, M.P., in the Chair.

ON THE SANITARY CONDITION OF THE BRITISH ARMY; AND ESPECIALLY ON THE WANT OF SPACE IN BARRACKS.*

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I have sought this opportunity of addressing you, because I wish to acquit myself of some part of that great debt of gratitude which, in common with all who devote themselves to the cultivation of the arts of peace, and who are not wholly insensible to its blessings, I

* In consequence of the interest attached to the subject of Barrack Accommodation, and its bearing upon the Health of the Soldier, it has been thought expedient to print the above Lecture out of its regular course, in order that it may the sooner be brought before the public.

feel that I owe to the brave men who fight our battles by land and by sea. I would fain render some slight service to those gallant men. But my debt to the navy must remain unpaid, because, as I need scarcely tell you, for the last three quarters of a century, since the memorable voyages of Captain Cook, the condition of the sailor in all that relates to the preservation of his health, and the enlargement of his comforts, has been one of progressive improvement, so that it is now scarcely possible for a civilian, like myself, to suggest anything that will conduce to his advantage. Not so, however, with the soldier: for I will undertake to say that there is no man, however ignorant he may be of sanitary science, however little knowledge he may have of the causes which tend to preserve health, or to destroy it; there is no one, how narrow soever his notions may be of the comforts which men in an humble sphere of life ought to enjoy, who could not, on the most cursory inspection of our barracks, and the most superficial knowledge of the routine of a soldier's duties, point out many things that would conduce greatly to his advantage, and which, if we would not altogether forfeit our old reputation for humanity, justice, sound sense, and true economy, ought, without one moment's delay, to be carried into effect. I do not therefore think that I lay myself open to the charge of presumption in coming before you, as a civilian, to talk to you, soldiers, upon this grave question, and to discuss the contents of the valuable Report which lies upon your table.

This Report, as most of you probably are aware, is entitled "The Report of the Commissioners appointed to inquire into the Regulations affecting the Sanitary Condition of the Army, the Organization of Military Hospitals, and the Treatment of the Sick and Wounded." It is a bulky volume, and contains, in addition to the usual summary and recommendations of the Commissioners, a great mass of evidence, and a very valuable Appendix. The Report is signed by the Right Honourable Gentleman now in the Chair, who has shown himself a true and tried soldier's friend, and who, I hope and believe, will maintain this character to the end of his days. This Report is also signed by several gentlemen, among whom are some of my personal friends. They are all of them men above suspicion, and quite incapable of intentionally misrepresenting or exaggerating the facts that were brought under their notice.

I may also speak in terms of similar commendation of the witnesses who have given their evidence before this Commission, among whom I may also mention that there are several of my personal friends; and I may undertake to say of them that, throughout the length and breadth of Europe, there are not to be found men, in their peculiar line, who could be brought into comparison with them. I speak of Sir Alexander Tulloch, Dr. William Farr, Mr. Neison, Dr. Balfour, and my old friend Dr. Sutherland, with whom I was associated fifteen years ago in sanitary movements and agitations. They are quite incapable of representing anything before this Commission which they did not believe to be true—they are quite incapable of exaggerating the evils under which the soldier is represented to be labouring.

I may also add that there will be found in the Appendix to this Report a very valuable paper, consisting of answers to written questions addressed to her by the Commission, from the pen of that gentle lady whose presence at the bedside of the sick soldier in the hospitals of the East was felt to be as rays of sunshine in a dark place—I mean Miss Nightingale. And it must be a great satisfaction to the soldier to know that, though she no longer ministers in person to his wants, she is now as deeply interested as ever in his behalf, and is labouring, with all the energy, zeal, and talent of a man, and all the gentleness, tenderness, and constancy of a woman, to promote to the utmost possible extent the welfare of the brave men to whose cause she is so warmly attached.

Now, this Report, to which I have thus cursorily alluded, brings into bold relief one great fact—one distressing and disgraceful fact—that the mortality of our soldiers, especially of the infantry, and more especially of the Foot Guards, is very much greater than that of any class of the civil population, with whom it seemed to be reasonable, and natural, and fair, to compare them. And when you reflect that the army is recruited from a population some of whom are conscious of defects that prevent them from ever offering themselves as soldiers, and others are rejected in large numbers when they do offer; when you bear in mind, too, that great numbers of soldiers are sent back, as invalids or pensioners, to the population from which they were drawn, to be reckoned when they die not as soldiers but as civilians, so as to swell the proper rate of

mortality of the civil population, and to diminish, in like proportion, that of the Army, you will be able to appreciate the gravity of this statement.

But this is no new fact; for at page 250 of the second volume of the Journal of the Statistical Society, published in 1839, there is a paper from the pen of Mr. I. W. C. Lever, in which he contrasts the facts contained in the then recent Report of Sir Alexander Tulloch, on the mortality prevailing among our troops during the seven years ending 1836, with similar facts relating to the civil population.

In that publication, the fact that British soldiers, and the infantry more especially, are subject to a very great mortality, as compared with civilians of the same ages, was clearly set forth. I have prepared a table embodying these facts, but, as I shall not have time to comment upon it at any length, I must be satisfied with directing your attention to it.

MORTALITY IN THE ARMY, 1830—1836.

(Annual Deaths in 10,000 living.)

—	All Causes.	Consumption.	Fever.
Household Cavalry	145	81	16
Dragoons and Dragoon Guards	153	77	14
West Indian Depôts	185	96	28
Foot Guards	216	141	17
French Army	195	—	—
Population of Towns, being Military Stations—Army Ages	160		
Population of London—Army Ages	150	Suicides = $\frac{1}{20}$ of Deaths among Dragoon Guards.	
Labourers E. I. C. S.	125		
Metropolitan Police	90		

You will find that the facts embodied in this table, relating to an earlier period of the history of our army, are in harmony with the statements made in this Report of Mr. Sidney Herbert's Commission, though the rate of mortality is higher at the earlier date. But I must invite your attention to one melancholy fact stated in the Table, that, among our Dragoon Guards, no less than one-twentieth of all the deaths was attributed to suicide.

I say, then, that this fact of the great mortality of the British soldier is no new fact. To our disgrace be it spoken, it was known

twenty years ago; and eleven years ago (in the spring of 1847) another fact was stated in the House of Commons in reference to our metropolitan barracks, which I think you will agree with me is not unlikely to bear to this high mortality of the soldier the relation of cause and effect. Sir De Lacy Evans told the House that, in the metropolitan barracks, a room 32 feet long and 20 broad, was all the convenience then afforded for the eating, sleeping, and general living of twenty men and non-commissioned officers, some two or three of the men being in all probability married. Such a room would probably not afford to each inmate more than from 250 to 300 cubic feet of air, or from a fourth to a third of the prison allowance. On the same occasion Colonel Lindsay stated that in one case he had found an allowance of 357 cubic feet, and in another of 330 cubic feet.* Therefore, neither the fact that the life of the British soldier is shortened, nor one of the leading causes to which I shall have occasion to attribute that curtailment of his life, are new to us. We ought long since not only to have known these facts, but we ought to have paid more attention to them.

The precise facts relating to the present mortality of the soldier, as compared with the mortality of civilians, are embodied in an intelligible form in the table before you.

DEATHS PER 10,000 PER ANNUM AT THE SOLDIERS' AGES.

London Fire Brigade (ages 40—60)	70
Metropolitan Police	76
England (Healthy Districts)	77
Agricultural Labourers	80
Out-Door Trades in Towns	85
Navy (Home Stations)	88
City Police	89
England	92
24 Large Towns	119
Manchester	124
Infantry of the Line	**187**
Foot Guards	**204**
Household Cavalry	**110**
Dragoon Guards and Dragoons	**133**

* I take this opportunity of stating that some passages in this Lecture are but slightly altered from similar passages in my article on "The Mortality in the Army," published in Fraser's Magazine for April. Having stated this fact, I do not deem it necessary to distinguish the passages in question by marks of quotation.

The facts, with one exception, are taken from the Report of the Commissioners. The exceptional case stands at the head of the table, and relates to an important class of men, of whom I shall presently give you some account—I mean the London Fire Brigade. The figures which exhibit the very favourable rate of mortality of this class are followed by those which display the mortality in several distinct bodies of civilians, namely, the Metropolitan Police, the inhabitants of the healthy districts of England, agricultural labourers, men following out-door trades in towns, the Navy on home stations, the City Police, the inhabitants of England and Wales, of twenty-four large towns, and of Manchester; and, by way of contrast, the mortality of the infantry of the Line, of the Foot Guards, of the Household Cavalry, and of the Dragoon Guards and Dragoons. The civilians thus compared with our soldiers are, in all cases, males of the same ages with the soldiers themselves, with the exception of the men of the Fire Brigade, whose ages range from 20 to 60. These men of the Fire Brigade, or London Fire Engine Establishment, occupy the most favourable position in the table. They are subject to an annual mortality of only 70 in 10,000, whereas the Foot Guards suffer a mortality of 204 in 10,000, or very nearly three times as many.

Now, this is the class of men of whom I said just now that I would give you some account. I am indebted for the particulars of their occupation and consequent mortality to Mr. Charles Frederick Browne, the surgeon to the force; and I am happy to see a gentleman here this afternoon (Mr. Braidwood, the superintendent), who can confirm the statements I am about to make.

The ages of the firemen range from twenty to sixty and upwards; and there is one man now in the service in his 70th year, quite able to take his turn of duty with the rest. The men are carefully selected, full three-fourths of them having been man-of-war's men. The duties they have to perform are by no means light; for each man, on the average, has been on duty at the stations, or on the watch on premises damaged by fire, three days and three nights, of twelve hours each, in every week of the past year. This is exclusive of attendance to clean the engines and tools, and keep the hose in order, and of a sort of engine-drill for the younger men twice a-week. The men have also to attend and work at fires, where they

are in the midst of intense heat, steam, and smoke, saturated with water, and obliged to stand in elevated situations exposed to severe and cutting winds, so that the men are often seen in winter literally encrusted with ice. They are sometimes called out by fires, or alarms of fire, as many as four times in a night. But, notwithstanding this hard duty and extreme of exposure, the rate of mortality among the men is highly favourable. For the first thirteen years of the establishment, the deaths were at the rate of 96 per 10,000; while for the last twelve years they have fallen to 70 per 10,000. Both these calculations include deaths by accident, which, in spite of the perilous nature of the employment, have not exceeded 44 in 10,000 in the whole period of twenty-five years. The higher mortality of the early period is attributed, and probably with justice, to less careful selection; but the moderate rate prevailing throughout the whole period of twenty-five years is evidently to be attributed to the unusual care and attention bestowed on the comforts and health of the men, who live either at the stations or in houses provided by the establishment, and subject to careful inspection. The management is in the hands of a Committee, appointed by the several Fire Assurance Offices, who pay the men liberally, give them plenty of warm and comfortable clothing, instruct the Medical Officer and Superintendent to look narrowly to the healthy state of the stations, and the other residences of the men, and act with promptitude and liberality on any suggestions which these efficient officers may please to make. This, I believe, is a fair and accurate account of this very healthy class of men.

Here, then, we have a case of night work and exposure to weather certainly far exceeding in severity the night duty which the foot soldier has to perform; for I understand that the soldier is on guard only every fourth or fifth night. Yet this night-work, and this exposure to weather, being accompanied, in the case of the Fire Brigade, by the most scrupulous care of the health and comforts of the men, is compatible with the very favourable rate of mortality shown in the Table. May not the unfavourable death-rate of 204 in 10,000, prevailing among the Foot Guards, be partly accounted for by the substitution of carelessness for care?

I infer, therefore, that night-work and exposure to the weather

do not of themselves occasion the great mortality of the Foot Guards. I infer that a man may have severe night-duty and much exposure to weather, and yet be long-lived; and this inference is confirmed and strengthened by the favourable rate of mortality prevailing among the Metropolitan and City Police, when compared with the Guards or with the Infantry of the Line. The police are much more exposed to the weather, and have much more night-work, and yet their rate of mortality is far below that of the foot soldier.

Let us next take the case of the sailor. He, too, has a good deal of exposure, and is subject at night to great over-crowding. His diet is also monotonous; and sometimes insufficient in quantity and defective in quality. But the sailor, as compared with the soldier, has a favourable rate of mortality, because, in common with the agricultural labourer, the unwholesome influences to which he is exposed are counteracted by strong and varied exercise in the pure open air.

I will next ask your attention to the class of men I have just mentioned—the agricultural labourers. Their rate of mortality also is given in the Table. Agricultural labourers are a very long-lived class of men. There is no large class of the community that lives so long. And yet these men attain to this longevity, in spite of great exposure to the weather, in spite of great overcrowding in their sleeping places at night, in spite of unwholesome dwellings, in spite of a monotonous and scanty diet, and very insufficient clothing: in defiance, as it were, of several of those evils which are supposed to attach to the condition of the soldier, and to account for his high mortality and short life. I conclude, therefore, that a man may be much exposed to the weather, that he may be greatly overcrowded at night, that he may be ill-clothed and badly fed, and yet, in spite of these unwholesome circumstances, if he have only hard daily labour in the pure open air, he may enjoy good health and attain to long life. The hard daily labour in the open air proves his salvation.

Let us now turn from long-lived men to short-lived men: from men having a favourable rate of mortality, though exposed to the action of certain unwholesome influences, to which, in common with

the soldier, they are subject, to men having an unfavourable rate of mortality, due to causes which may also be presumed to contribute to shorten the soldier's life. The class to which I shall first invite your attention is the English aristocracy. I am able to compare their expectation of life with that of the agricultural labourer; and I find that, while the agricultural labourer at thirty years of age has an expectation of forty years and a half, the English aristocracy has an expectation of only thirty-one years. So that between the agricultural labourer, with all his privations and disadvantages, and the English aristocracy, having every comfort and luxury which wealth can purchase, there is a difference as against the aristocracy of nine years and a half. Now I want to draw your special attention to this favoured class, and the circumstances under which they are placed. At first sight, the position of the aristocracy would seem a very enviable one. They are able to guarantee themselves against all the causes which undermine the health and destroy the lives of the poor; but hereditary wealth, whether in the hands of men born in the ranks of the aristocracy or out of them, has this serious drawback, that it creates a great difficulty in finding a suitable, active, vigorous, exciting, interesting employment. Its possessor, therefore, naturally falls into idleness and dissipation, and this, with luxurious living, inevitably shortens his days. This is a very important fact, because it bears upon the mortality of the soldier, and illustrates some of the evils of his condition.

My object in bringing this fact thus prominently forward will at once appear, if I read to you a statement made by Colonel Lindsay in reference to the want of interest which the soldier has in his occupation, and the consequent temptations into which he falls—temptations allied to those that beset the path of the aristocracy, though, as I need scarcely tell you, divested of the element of luxury, of which the soldier has little enough. Colonel Lindsay tells us that the Foot Guards get up at six o'clock, make their beds, clean their things, and get their breakfasts at seven; that they turn out at half-past seven or eight for a drill; but that if it be guard day, there is no drill, except for defaulters. The men for duty are paraded at ten o'clock, and that finishes the day's drill altogether. There is evening parade, which takes

half an hour; and then the soldier's time is his own till tattoo, which is at nine in winter and at ten in summer. This is the day of a soldier not on guard, or not belonging to a company out for Minié practice. Now as to the consequences of this idle and lounging life: "Perhaps," says Colonel Lindsay, "no living individual suffers more than he from *ennui*. He has no employment save his drill and his duties. These are of a most monotonous and uninteresting description, so much so that you cannot increase their amount without wearying and disgusting him. All he has to do is under restraint; he is not like a working man or an artisan. A working man digs, and his mind is his own; an artisan is interested in the work on which he is engaged; but a soldier has to give you all his attention, and he has nothing to show for the work done."

Here, then, we have a graphic description of a man handed over by our military authorities for a prey to listlessness, idleness, and dissipation.

I think, therefore, that, setting luxury aside, in which certainly the foot soldier has no means of indulging, he is subject to the same evils which beset the aristocracy of this and all other countries. If our own aristocracy suffer less from these causes than the aristocracy of other countries, that happy result is due to that love of enterprise, that fondness for work for work's sake, which seems born and bred in Englishmen of all classes from the highest to the lowest. This it is that saves the aristocracy of England from that extreme of degeneracy into which so many other privileged classes in all ages of the world have fallen.

There are still one or two other classes to which I must ask your attention, in order that I may explain my own views of the causes of the excessive mortality to which the soldier is subject. One of the classes to which I allude consists of men who work in-doors with a great deficiency of exercise, at the same time that they inhale a close, heated, and impure atmosphere. This is the case of tailors, and of compositors in printing offices, whose health is destroyed, and their lives greatly curtailed, by these causes. It is the case also of clerks, though they suffer more from want of exercise than from want of air. I might prove my position by figures; but I prefer stating in general terms, that there is no doubt whatever that

the lives of men who are thus employed are shortened by confinement and insufficient exercise. Another class of men subject to a high rate of mortality from causes that affect the soldier consists of those who indulge in intemperance. The brewers' draymen and licensed victuallers are well known to be exposed to this temptation, and are equally well known as very short-lived men. Thus, if we compare the brewers' draymen with the whole body of labourers working out of doors, among whom, of course, there are many intemperate men, we find the draymen's lives so curtailed by this baneful habit that at thirty-five years of age their mortality is double that of the labourers. Similar comparisons between licensed victuallers and the whole body of tradesmen, and between potboys and footmen, give the same general result.

I think that I have now sufficiently prepared you for the study of a tabular comparison, in which I have arranged in one column some of those causes that are usually alleged as shortening human life, and which are also believed to injuriously affect the life of the soldier. The rest of the Table consists of eight columns, four of which have black and four red headings. The first four (those with black headings) are instances of favourable durations of life; and the last four (those with red headings) are instances of unfavourable durations of life.* The stars indicate the presence of the several causes of disease in the classes at the head of the columns.

Cause of Disease.	Agricultural Labourers.	Sailors.	Police.	Fire Brigade.	Aristocracy.	Tailors, Compositors, Clerks, &c.	Draymen, Licensed Victuallers, &c.	Soldiers (Infantry).*
Over-crowding, or Want of Air	*	*	. .	. .	. .	*	. .	*
Deficient Exercise . .	. .	. .	. .	. .	. .	*	. .	*
Defective or Monotonous diet .	*	*	. .	. .	. .	. .	. .	*
Inadequate Clothing . .	*	. .	. .	. .	. .	. .	. .	*
Night-work or Night-duty .	. .	*	*	*	. .	. .	. .	*
Exposure to Weather . .	*	*	*	*	. .	. .	. .	*
Intemperance . . .	. .	. .	. .	. .	. .	. .	*	*
Luxury	. .	. .	. .	. .	*	. .	. .	. .
Dissipation	. .	. .	. .	. .	*	. .	. .	*
Insufficient Occupation . .	. .	. .	. .	. .	*	. .	. .	*

* In the annexed Table the two sets of columns are distinguished by a difference of type.

Let us take the several classes one by one, and see what lessons we can learn from them. First comes that long-lived class the agricultural labourers. The agricultural labourer, as I have said, is subject to over-crowding; he has a defective, scanty, and monotonous diet; his clothing is not of the best; and he suffers much from exposure to the weather. Take next the sailor. He is over-crowded in his berth at night; his diet is not varied, and in long voyages is apt to be defective; he has a good deal of night duty, and is much exposed to the weather: still, he does not die off as the soldier does. The police come next in order. They have night-duty, with great exposure to weather; and so have the Fire Brigade, whose case I have brought specially under your notice,—and yet they, too, are not short-lived. The men of the Fire Brigade are very much the reverse.

We now come to the four short-lived classes. We will begin with the aristocracy, whom I have taken the liberty of representing as liable to fall into the twin vices of idleness and dissipation. I speak of them as a class, and of their habits of life, as a rule to which I know that there are many exceptions. But as a class they have not sufficient employment to maintain them in health and vigour, and they are short-lived. My next unhealthy class consists of such men as clerks, compositors, and tailors. They work in close and crowded rooms, and have little or no exercise —and they, too, are short-lived. Then comes the class consisting of such men as are tempted by the very nature of their occupation to indulge in spirituous liquors to excess—the class to which belong brewers' draymen and licensed victuallers. They are intemperate; and they, too, are short-lived. The unfortunate soldier comes last of all, with a star against every cause of disease but one—luxury. It is alleged by those who are now engaged in finding out the causes of his excessive mortality, that he is over-crowded; that he sleeps in a close, confined, and fœtid atmosphere; that he has not such exercise as is calculated fully and freely to develop his frame; that he has a defective and monotonous diet; that his clothing does not afford adequate protection from the weather, especially when he is on night-duty; that he has this night-duty to perform under very unfavourable circum-

stances; that he is given to intemperance; that he is extremely dissipated; and that his occupation is insufficient. Here, then, you have the shortest-lived class of all; and you have all these causes alleged, in explanation, some by one person and some by another, but all of them by persons who have thought upon the subject, and whose opinions are entitled to respect.

From this comparison of soldier with civilian, I now pass to a comparison of soldier with soldier. At the foot of the Table (at p. 5) you have the mortality of the Infantry of the Line and Foot Guards compared with that of the Household Cavalry and of the Dragoons and Dragoon Guards. You see that the mortality of the Infantry of the Line and Foot Guards is much more considerable than that of the Household Cavalry, or than that of the Dragoons and Dragoon Guards. Without entering into the more minute differences existing between the Cavalry and Infantry, in regard to the amount of pay, the class from which the men are taken, the degree of care with which they are enlisted, and minor matters of that sort, I will go at once to the broad differences between them. I know of two such differences. The one is that the cavalry soldier is a soldier and something more. He is a soldier and a groom; and every one who knows what the work of a groom is, knows that it requires a good deal of exertion of the whole body —not simply the contracted and constrained movements of the arms and legs, which make the foot soldier on drill look so much like an automaton, but vigorous movements of the whole frame—good, strong developing exercise of the chest and body. The other difference is that the Cavalry have more space by one-fourth or one-fifth than the Foot Guards.* These two advantages, then—vigorous, varied, and wholesome exercise, and greater space in barracks—will go far to explain the very different rates of mortality prevailing among the Cavalry and Infantry.

So much, then, for the mortality of soldiers as compared with the mortality of civilians of the same ages; and so much for the mortality of the Infantry as compared with that of the Cavalry. I have now to speak of the diseases which destroy the soldier's life. There are two classes of disease which are the special foes of the

* See Tables ii. iii. and v. in the Appendix.

soldier, and particularly of the Infantry soldier: namely, epidemic maladies, of which fever is the chief; and diseases of the chest, of which consumption is the most fatal.

One of the great characteristics of fever is that it is a disease of crowds and of crowded places;—of crowded prisons, crowded workhouses, crowded ships, crowded hospitals, crowded camps, crowded barracks. If you confine men in a narrow space, fever will certainly break out among them sooner or later; and it is in such places that it spreads most rapidly from person to person, when it happens to be introduced from without.

Cholera, again, is one of those diseases which finds out overcrowded and otherwise unwholesome places. Accordingly, it found out our barracks in 1849; and we learn from the Report that in some of our barracks it destroyed from twice to more than five times as many soldiers as it did civilians in the surrounding districts. We are told that, while the civil population of East London and Whitechapel lost 54, the soldiers in the Tower lost 100 in 10,000; that, while the civil population of St. Pancras lost 22 in 10,000, the soldiers in Regent's Park perished at the rate of 104 in 10,000; and that, while the civil population of Kensington lost 33 in 10,000, the mortality among the soldiers at Knightsbridge was no less than 175 in 10,000.

The Table, compiled from the paper in the Journal of the Statistical Society to which I have already referred, shows that the mortality from consumption in the army twenty years ago was very considerable. In the Household Cavalry it was 81, in the Dragoons and Dragoon Guards 77, in the West India depôts 96, but in the Foot Guards it was 141 in 10,000. That this sad state of things, though somewhat improved since that date, is not yet remedied, the following extract from the Report of the Commissioners will show. Diseases of the lungs, which in the civil population of large towns cause 58 deaths every year in 10,000, destroy 64 in 10,000 of the Household Cavalry, 66 in 10,000 of the Dragoon Guards and Dragoons, 89 in 10,000 of the Infantry of the Line, and 125 in 10,000 of the Foot Guards; and, when compared with other causes of death, these diseases are found to prove fatal in the proportion of about 54 per cent. in the Cavalry,

of about 57 per cent. in the Infantry of the Line, and of about 68 per cent. in the Foot Guards.

I may state in passing (I shall speak more at length on this point presently) that there is no doubt whatever that over-crowding is one of the most efficient causes of consumption; so that, if fever may be looked upon as the acute disease of crowds, consumption may be considered as their chronic malady. But the dependence of pulmonary consumption on over-crowding will be best discussed when I have asked and answered this question,—Are our barracks and military hospitals over-crowded? I will give you the means of judging for yourselves by stating a few facts relating to different periods of time. You have the Tables before you *—Tables which I have been at some pains to compile from the returns published in the Appendix to the Report of the Commission—but I will read to you the general results.

Let me first remind you again of the statements made in the House of Commons in 1847, by Sir de Lacy Evans and Colonel Lindsay, respecting the disgraceful want of space in some of our London barracks. These statements produced just enough effect upon the House to cause some Member or other to move for a Return of the cubic space in barracks throughout the country, which Return was printed in 1848, and supplied us with some facts worthy of a place at the side of those I have just referred to. This Return gives us examples of barrack-rooms in London used as dormitories and day-rooms by grown-up men (tall, strapping fellows, as many of our soldiers are), affording to each man only 397 cubic feet of air to breathe, and worse cases still of 390, 376, 370, 363, 331, and in the case of a temporary barrack at Kensington, 285 cubic feet. In other parts of the United Kingdom the figures are still more unsatisfactory—still more disreputable. At Chatham and Upnor (I am still speaking of 1847) the Infantry were put upon the miserably short allowance of 220 cubic feet of air per man (the maximum at Chatham was only 350); the Cavalry at Maidstone were doomed to 174 cubic feet; and the soldiers in Dover Castle must have been rotting, like sheep in the marshes, in a filthy atmosphere, measured out at the starvation rate of 147 cubic feet

* See the Appendix.

per man. Scotland was favoured with a minimum supply of 240; but Ireland presented a series of low averages, falling from 228 at Portumna and Mallow to 158 at Rutland.

The average space in the 11 Returns from London was 400 cubic feet; 143 Returns from Ireland yielded the same average; 34 from Scotland gave an average of 432; and 155 from England, 447 cubic feet. This was in the year 1847; and who, with these facts before him, can be surprised at the outbreak of cholera in our London barracks in 1849? Who can be surprised at the prevalence of fever and consumption among our soldiers?

Since 1847, as many as 142 new barracks have been erected, of which 132 are in England; and we have another Return showing the cubic space in the barrack-rooms of these new buildings. Of the whole number, two afforded a space of less than 300 cubic feet, four others a space of between 300 and 350, seventeen others a space of from 350 to 400, and fifty-nine barracks a space of from 400 to 500 cubic feet; in sixty barracks only was the space of 500 cubic feet per man exceeded. The barrack-rooms, properly so called, do not yield an average space of more than 550 cubic feet; and instances are given of such contracted spaces as 308, 306, 303, and even 280 and 270 cubic feet.

Let us now come to the present time, and see what this Report has to say upon the subject. We are first told that the new barracks erected since 1855, when the Barrack Committee held its sittings, afford very superior accommodation to those previously built, but that no important steps have been taken towards supplying the deficiencies of the older buildings; that some of the most serious evils remain still unremedied; that the dormitories or barrack-rooms are very confined, and that in a majority of cases, even the minimum cubic space allowed to each soldier by regulation is not attained, the deficiency in a number of barracks amounting to one-third and in some instances to more than one-half of the space allotted by regulation.

And now mark the contrast afforded by the Scotch pauper and the British soldier. We have it on the authority of Sir John McNeill, that the pauper in the Scotch workhouses is allowed 480 cubic feet per bed, and that this minimum is not only rigidly

insisted upon, but that, the houses being scarcely ever full, it is practically much exceeded ; and, moreover, that the pauper is never in his dormitory during the day. In the soldier's barrack, on the other hand, it often happens that even the regulated space of one foot between the beds (I am quoting the very words of the Report —*one foot between the beds!*) is practically unattained. The Report goes on to say that the barrack-rooms very seldom have windows at the opposite sides or ends of the rooms ; that where ventilators exist they are frequently stopped by the men themselves (of course they are, for you cannot safely practise ventilation in these narrow spaces) ; that barrack-rooms are occasionally found in the basement of the building, approached by descending steps from the natural surface level—the tops of the windows, which open on one side only of the rooms, being little, if at all, above such surface level—and that in low rooms thus situated a number of men may be found lodged in beds so closely ranged that the side of one touches the side of the other. The result is, that the soldier sleeps in a fœtid and unwholesome atmosphere. This, let me remind you, is just such a state of things as John Howard, to his surprise and sorrow, found prevailing in our prisons in the year 1774 : just such a state of things as the Legislature of that day thought too bad even for the worst of their inmates. But perhaps you will attribute this narrowness of space in our barracks, old and new, to the ignorance of the architects or the perverseness of commanding officers in putting more men into the rooms than they were intended to hold. No such thing. The persons immediately concerned, if they were not obeying the letter, were acting in the spirit, of the instructions they received, as you will see when I tell you that the "Orders and Regulations for the Guidance of the Corps of Royal Engineers and Royal Sappers and Miners at Home and Abroad, revised, by Order of the Master General and Board of Ordnance, to 1st January, 1851," prescribed only from 400 to 500 cubic feet per man in temperate climates, and from 480 (the Scotch pauper's allowance at home) to 600 in tropical climates, with a proviso that in general the maximum space was to be allowed, and for single bedsteads. The Report of the Commissioners recommends 600 cubic

feet to each man. This, you will say, is an extremely moderate allowance; and I hope that the nation which does not think 480 cubic feet too much for a Scotch pauper, and does not grudge 900 cubic feet, with ventilation superadded, to the prisoner at Pentonville, will be able to afford this moderate supply of 600 cubic feet to the English soldier.

Now, by way of contrast, let us see how benevolent persons, moved by motives of economy, and anxious to make a profit by providing decent accommodation for the poorest classes, behave towards their clients. In the year 1848, the model lodging-house in George Street, St. Giles's, was opened with great state and ceremony by His Royal Highness the Prince Consort, who presided at a public meeting held at Freemasons' Tavern. I do not know whether our Chairman was present, but many distinguished persons were there, and all the world heard of it, and seemed to take an interest in it. This model lodging-house was intended to supply the conveniences and comforts of life to the poorest class of the people for the very low charge of four pence a night. For this small sum of money the Society for Improving the Condition of the Working Classes contrived to furnish their lodgers with many comforts and luxuries. There was a separate coffee-room, with a good fire and constant supply of hot water; each lodger had his own sleeping room separated from his neighbours; water and gas were laid on; there was a good kitchen, with facilities for boiling, roasting, baking, and frying; a pantry with a separate cupboard for his provisions; lavatories, a cleaning room, hot and cold baths, and other conveniences which I cannot stop to specify. Now, what cubic space did these gentlemen think it necessary that an honest working man should have to breathe? Why, 542 cubic feet. That is what they gave him. I have worked out the calculation, and it comes to that. So that these excellent people, catering for the very poorest class of labouring men, having an anxious regard to economy, and wishing to establish an example of profitable investment, provide dormitories, to be used only as such, with 542 cubic feet of air to each inmate, while three years later the Board of Ordnance were not ashamed of prescribing from 400 to 500 cubic

feet of air as a fit and proper allowance for the British soldier in barrack-rooms destined to the two-fold use of dormitories and day-rooms.

One word as to the accommodation for married soldiers. It appears from a Return presented to the House of Commons in 1857, that out of 251 stations there were only 20 in which any separate accommodation was provided for married soldiers. When such separate accommodation is provided, it seems to be on a par with the provision made for the single soldier in barrack-rooms. At Dover, we are told that it consists of rooms 12 feet 7 inches long by 7 feet broad and 7 feet high, affording for a whole family a cubical space of little more than 600 feet. At Woolwich, a staff-sergeant with his wife and five children sleep and live in one room, in which all the household labours are performed. In the casemates at Chatham the overcrowding is greater, and the decencies of life are still less regarded.

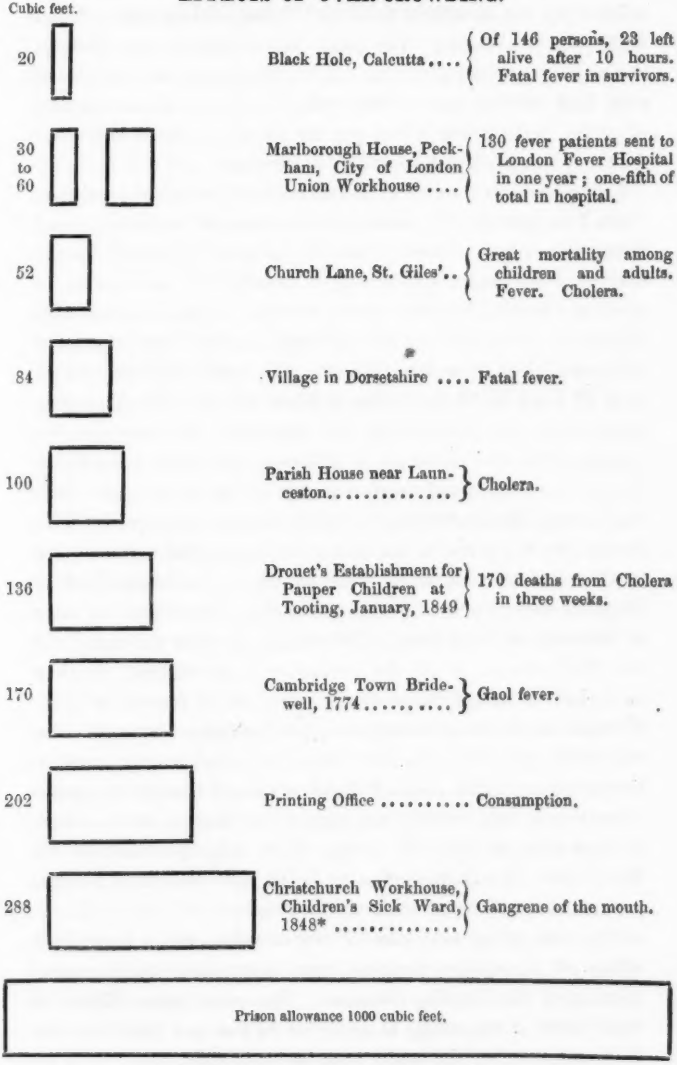
From barracks let us turn to hospitals, and see what the theory and practice of the Board of Ordnance was in respect of these important buildings. I will begin, as before, with the year 1847. At that time no less than fifteen wards of Military hospitals, in different parts of the country, gave an average supply to their sick inmates of less than 400 cubic feet of air; and the Return contains figures falling by easy gradations from 392 to 385, 365, 357, 348, 346, 344, 325, 324, 286, 264, 256, 243, 236, and 213. The mean of 265 averages, taken in every part of the United Kingdom, is only 643 cubic feet per patient. Now the least average space per patient in London hospitals, as appears from a recent Return obtained by Dr. Balfour, the Secretary to the Commission, is 800 cubic feet; the least from any County hospital, 653 cubic feet; the least from any Naval hospital, 752 feet; but the least cubic space allotted to a patient in any Military hospital is 400 feet, or precisely half the minimum space in any metropolitan hospital. This small figure of 400 cubic feet occurs twice in the 46 Military Returns, and in no less than 19 other instances the cubical space per patient falls short of the minimum prescribed by the Board of Ordnance in 1851. The mean results of all the average measurements are equally unsatisfactory; for while the London hospitals

give a numerical average of 1,472 cubic feet, the Provincial hospitals of 1,075 cubic feet, and the Naval and Marine hospitals of 1,014 cubic feet, the Military hospitals afford to their patients only 658 cubic feet.

I think I have now proved to you conclusively that there is over-crowding in our barracks, that there is over-crowding in the rooms of married soldiers, and that there is over-crowding in our Military hospitals.

Now as to the effects of this over-crowding; as to the consequences of having so little air to breathe. I will begin with some extreme cases, the particulars of which are given in a few words in the table before you. You will please to understand that the height of the parallelograms, on the lefthand side of the table, is in every case supposed to be 10 feet, and the depth 1 foot, so that the areas correspond very closely with the cubic spaces themselves, and present them very clearly to the eye. A second column of the table specifies the scenes of the over-crowding, and a third column the result of it. I begin with the tragedy in the Black Hole at Calcutta—a place that has a special interest at this moment, when our minds are so much engrossed with painful events in India. Of 146 persons shut up in that narrow space, with only about 20 cubic feet of air per head, one-third died in less than three hours, and only 23 were left alive at the end of ten hours. The greater number of this small band of survivors were seized with a putrid fever and died. The next case of over-crowding comprised in the Table is that of Marlborough House, Peckham, the Union Work-house of the City of London, in which the male paupers of the city were farmed out, from the formation of the union in 1837 till a comparatively recent period. This municipal Black Hole was a sort of shed, 7 feet pitch in the centre, and 2 feet at the sides where the men's heads rested at night; and its dimensions were such as to give to each wretched inmate from 30 to 60 cubic feet of air to breathe. At its fullest, it is said to have held from 90 to 100 men. As the room was 33 feet 9 inches long, and 20 feet wide, it will be easy to calculate the space on the floor allotted to each man. As the number of inmates ranged from 50 to 100, let us take it at 68, and call the length of the place 34 feet. If the men were arranged

EFFECTS OF OVER-CROWDING.


Cubic feet.
20
Black Hole, Calcutta....
Of 146 persons, 23 left alive after 10 hours. Fatal fever in survivors.
30 to 60
Marlborough House, Peckham, City of London Union Workhouse....
130 fever patients sent to London Fever Hospital in one year; one-fifth of total in hospital.
52
Church Lane, St. Giles'..
Great mortality among children and adults. Fever. Cholera.
84
Village in Dorsetshire .... Fatal fever.
100
Parish House near Launceston.....
Cholera.
136
Drouet's Establishment for Pauper Children at Tooting, January, 1849
170 deaths from Cholera in three weeks.
170
Cambridge Town Bridewell, 1774.....
Gaol fever.
202
Printing Office ..... Consumption.
288
Christchurch Workhouse, Children's Sick Ward, 1848*.....
Gangrene of the mouth.
Prison allowance 1000 cubic feet.

* In one ward 132 cubic feet. 288 cubic feet is the average of a number of wards.

in two rows, each man must have had exactly 2 feet, or about the width of his own shoulders, to lie on! Close packing this. Well! What was the result? The place was a perfect fever factory. It sent 130 fever patients to the London Hospital in one year, being more than one-fifth part of the total admissions. The ratepayers, of course, had a pretty bill to pay for all this—a much larger one than they imagined, or I know how to calculate.

I now come to a case of over-crowding of which a gentleman whom I see present (Mr. Neison) is cognisant, for he, with Colonel Sykes and myself, formed a small committee appointed by the Council of the Statistical Society, to examine the scene of it. I speak of Church Lane, the solitary survivor of the once notorious rookery of St. Giles's. In this miserable lane we found a number of rooms so densely crowded, that the cubic space per person ranged from 93 down to 52 feet. The sickness and mortality prevailing among these wretched people was frightful. We compared the mortality with that prevailing at Islington, and found it double for the first year of life, and nearly sevenfold for the second year. Like Marlborough House, too, the houses of this lane were a perfect fever factory; for in a period of less than seven months 139 persons living in Church Lane were under treatment by the workhouse staff, of whom 88 were ill of fever. One house alone contributed 22 cases of sickness and 14 of fever. The cholera of 1849 also found out this filthy lane, as it did the barracks of our soldiers. In little more than one month the pestilence carried off 29 persons, of whom 17 were inmates of the houses which our committee inspected. This was at the rate of 6 in the 100, while the model lodging-house in George Street, within a stone's throw of Church Lane, with a population also of 100, lost only one man by that disease, and he a man of very advanced age. In another model lodging-house near old St. Pancras Church, there was no death from cholera in a mixed population of 500 men women and children.

The scene of my next case of over-crowding was a house in a village of Dorsetshire, described some years since by the correspondent of the Morning Chronicle. The cubic space allotted to each inmate of the cottage at night was 84 feet, and fatal fever was the result, reducing the family from twelve to eight.

I now come to speak of larger spaces. Before the erection of the Union workhouses, the poor were accommodated in poor-houses or parish-houses, some of which have since been let out for small weekly sums to persons just on the verge of pauperism. In one of these parish-houses near Launceston, the space amounted to 100 cubic feet for each inmate, and in one such house the cholera carried off five victims and dispersed the remainder.

My next example of over-crowding is Drouet's establishment for pauper children at Tooting. The space in the dormitories afforded to each child 136 cubic feet, and that one establishment contributed to the death-roll 170 deaths from cholera in three weeks, in addition to 15 deaths in the workhouses to which the children were removed, and 8 deaths by similar diseases, making a total mortality of 170.

I have been able to extract from Howard's work on prisons one instance (namely, the town bridewell at Cambridge) in which I could calculate the cubic space; it amounted to 170 feet: gaol-fever attacked the inmates, closed the establishment, and proved fatal to three out of the seventeen women confined there.

I have myself examined a number of printing offices in which the space is very limited, and in one of them I found the average space to be 202 cubic feet. Consumption was unusually prevalent there. I have a very distinct recollection of a still worse office than this, in which consumption was so prevalent that it created the same alarm that a contagious fever would have done.

My last case of over-crowding forms one of the worst instances of totally inadequate space recorded by the Poor Law Commissioners in 1848. The cholera was expected, and the Poor Law authorities wanted to know what accommodation the London workhouses afforded for the reception of patients suffering from that disease. One of the worst of many bad cases recorded on that occasion was the case of the Christ Church Workhouse. Its sick wards actually yielded an average of 288 cubic feet per patient; and one of the wards gave only 132 cubic feet for each inmate. In this instance the prevalent disease was gangrene of the mouth, a very fatal and intractable malady. Some external nuisances contributed to this result, but the disease prevailed whatever the direction of the wind. Now, by way of contrast to these cases of over-crowding,

I place, at the foot of the Table, the prison allowance of 1,000 cubic feet. It is usually set down at this figure, but we have it distinctly given in evidence before Mr. Sidney Herbert's Commission by Colonel Jebb, that in Pentonville prison the allowance is 900 cubic feet per prisoner, *plus* ventilation. In the cases I have just commented on, and in the barracks of the soldier, the narrow spaces are either *minus* ventilation, or they are accompanied by attempts at ventilation which the narrowness of the space renders either abortive, or, from the severity of the drafts, highly dangerous.

The cases which I have just been describing are intended to show the baneful consequences of over-crowding carried to an extreme. But I think it fair to infer that very disastrous consequences may, and do, result from much less degrees of over-crowding than these—from such over-crowding as exists in all our barracks at the present moment. But perhaps you will call for some clear case of over-crowding among soldiers, followed by some such consequences as I have been describing. Fortunately I am prepared with such a case, on the high authority of M. Boudin, a French sanitary reformer well known in this country.

"During the period from 1843 to 1847 inclusive, I ascertained," he says, "the existence every year, at the Military Hospital of Versailles, of a fatal epidemic of typhoid fever, raging about the month of October among the sick who came to me from the garrison of St. Cloud. The epidemic had this remarkable feature, that it broke out every year eight days after the arrival of the ex-King, and that it disappeared immediately after his departure from St. Cloud, without ever attacking either the civil population or the officers, or even the *sous-officiers*, though these latter inhabited the same barracks as the corporals and soldiers. The following facts give the key to this pathological enigma. The garrison of St. Cloud in ordinary times consisted of from 400 to 500 men, and had scarcely any sick, but on the arrival of the King the garrison was increased to 1200. The men were then crowded into a narrow and ill-ventilated room, whilst the *sous-officiers*, better fed and less harassed with duty, had always at least one room for two men." This is a striking and an interesting illustration of the efficacy of over-crowding in producing fever.

Now, let me ask your attention to a fact or two with regard to consumption. I want to show you that this disease, too, may be brought on by over-crowding. A gentleman now present, (Dr. Neill Arnott,) in his evidence before the Health of Towns Commission, tells the following instructive story about certain monkeys in the Zoological Gardens. "A new house," he says, "was built to receive the monkeys, and no expense was spared which, in the opinion of those entrusted with the management, could ensure to those natives of a warmer climate all attainable comfort and safety. Unhappily, however, it was believed that the object would be best secured by making the new room nearly what an English gentleman's drawing-room is. For warming it, two ordinary drawing-room grates were put in as close to the floor as possible, and with low chimney openings, that the heated air in the room should not escape by the chimney, while the windows and other openings in the walls above were made as close as possible. Some additional warm air was admitted through openings in the floor from around hot-water pipes placed beneath it. For ventilation in cold weather, openings were made in the skirting of the room close to the floor, with the erroneous idea that the carbonic acid produced in the respiration of the animals, become heavier than the other air in the room, would separate from this and escape below. When all this was done, about sixty healthy monkeys, many of which had already borne several winters in England, were put into the room. A month afterwards more than fifty of them were dead, and the few remaining ones were dying. This room, open only below, was as truly an extinguisher to the living monkeys, as an inverted coffee-cup held over and around the flame of a candle, is an extinguisher of the candle. Not only the warmth from the fires, and the warm air that was allowed to enter by the openings in the floor, but the hot breath and all the impure exhalations from the bodies of the monkeys, ascended first to the upper part of the room to be completely incorporated with the atmosphere there, and by no possibility could escape, except as a part of that impure atmosphere, gradually passing away by the chimneys and the openings in the skirting. Therefore, from the time the monkeys went into the room till they died, they could not have had a single breath of fresh air.

It was only necessary to open, in the winter, part of the ventilating apertures near the ceiling, which had been prepared for the summer, and the room became at once salubrious." I have only to add to this story the fact, that the disease of which these animals died was consumption, to convince you of the fatal efficacy of foul air in producing that disease. The general accuracy of this story was confirmed by a colleague of my own at King's College, (Professor Rymer Jones,) who informed me that similar results followed similar treatment in other animals, with this addition, that when a more liberal supply of air was afforded them, they manifested a somewhat inconvenient increase of appetite. I have no doubt that the same result will happen when our soldiers have a larger supply of air; but I trust we shall be able to afford the increased outlay for food, and shall not grudge it.

You will perhaps object to this monkey-case, and to other analogous facts relating to animals, that they are not quite applicable to the human subject. If so, I am happy to say that I can satisfy your minds. I am able to prove to demonstration, that if you do put men into such narrow spaces as our soldiers are condemned to live and sleep in, they will certainly die of consumption. Several years ago, being struck with the high rate of mortality prevailing among letter-press printers, I went carefully through a great number of printing offices and made the inquiries I am about to describe. I may premise that the compositors, who set up the types, use very little exertion in their employment, and are often pent up in very narrow spaces, breathing a heated and impure atmosphere. The great majority of the men to whom my inquiries were addressed were compositors—a few only were pressmen. I measured the area of the several rooms with the utmost care, and calculated the cubic space to each inmate; and I put a few plain questions to each man—the same questions in each case. I inquired of each man particularly whether he had ever spit blood, and to what other diseases he was subject. The object of this first question will be very apparent to a medical man. Spitting of blood is one of those symptoms which is so common in consumption, and so rare in other diseases, that if we are dealing with a considerable number of persons, and comparing one large group with another, this symptom

of spitting of blood may stand for consumption without leading to any serious error. Now, the results of these careful inquiries are

TABLE X.

TABLE SHOWING THE CONNECTION OF PULMONARY CONSUMPTION AND OVER-CROWDING.

—	Spitting of Blood.	Catarrh.	Other Diseases.	Total.	Per-Centage Proportion. Spitting of Blood.	Catarrh.	Other Diseases.	Total.
104 men having less than 500 cubic feet of air to breathe .	13	13	18	44	12·50	12·50	17·31	42·31
115 men having from 500 to 600 cubic feet of air to breathe .	5	4	23	32	4·35	3·48	20·00	27·82
101 men having more than 600 cubic feet of air to breathe .	4	2	18	24	3·96	1·98	17·82	23·76

embodied in the table before you ; and I look upon them as peculiarly important at this moment, as they seem to form the very key-stone to the arch built up by Mr. Sidney Herbert's Commission. I encountered 104 men unfortunate enough to have less than 500 cubic feet of air to breathe, the average, of course, being much less than that. Now, these men had spit blood at the rate of 12½ in every hundred ; and the same number, 12½, said that they were constantly suffering from what they called colds. I found another body of 115 men who had from 500 to 600 cubic feet of air to breathe, and, therefore, very much more than the first group, of whom some had, as you have seen, as little as 202 cubic feet of air to breathe; and these 115 men, instead of suffering to the extent of 12½ in the 100 from spitting of blood, suffered at the rate of little more than 4 per cent., while the liability to colds fell in nearly the same proportion. Lastly, I found a third group of 101 men who had more than 600 cubic feet of air to breathe, and their liability to consumption was still further reduced to a little less than 4 per cent., and their liability to colds to a little less than 2 per cent. If I had more time, I could give you two or three other comparisons of the same kind, leading to the same result.

I do not think that there is any fallacy about these facts. I can

answer for it that I did not make these observations and calculations with the most remote desire to arrive at any particular result, but only to ascertain the truth. I speak therefore with the utmost confidence when I say, that if you will limit men in the quantity of air that they have to breathe, and bring it down to such low averages as you have in your barracks, and, especially, if you do not provide sufficient exercise for them, you will inevitably have a great deal of consumption. I may mention, by the bye, that the fine dust from the sanded floors of the barrack-rooms, and the dust of the pipe-clay from the belts, gloves, and white jackets of the Guards, are not very favourable to men with weak lungs.

I have thus demonstrated to my own satisfaction, and I trust to yours also, three leading facts : First, that a very high rate of mortality prevails among our soldiers generally, but especially our foot soldiers ; Secondly, that our barracks and hospitals are greatly over-crowded ; and, Thirdly, that this over-crowding issues in fever, cholera, and such like diseases on the one hand, and diseases of the chest, but especially consumption, on the other.

It is now time that I should think of bringing this Lecture to a close. I have given you a mere outline of a very great and very grave subject. I have displayed the facts of the case as clearly as I could, and I have to the best of my belief explained the causes. I would again and again insist on the two great evils of over-crowding of barracks and hospitals, and the want, considering the class of persons with whom we have to deal, of sufficient exercise. I do not expect—I have no right to expect—that all those whom I have now the pleasure of addressing should agree with me as to the causes which give rise to this high mortality of our soldiers. The only agreement that I seek for is a hearty determination to co-operate, according to our respective opportunities, to bring it about that the state of things described in this Report shall exist no longer.

But if there is any one now present who attaches special importance to one of the alleged causes of the soldier's mortality rather than another, let that man exert himself to get that evil remedied. If any one thinks that the figures which represent that mortality are not strictly accurate, let him do all he can to obtain weekly

returns of the deaths and attacks of sickness occurring among all our troops in the United Kingdom; and let those weekly returns be compared minutely and carefully with the deaths among the civil population of the soldiers' ages, that we may know the truth, and know it in such good time as to be able to act upon it; so that whenever any military station is found to be subject to an unusual mortality, some skilful person may be despatched to investigate the cause of it, and, within certain necessary limits of expense, to rectify it. Let us also have similar returns from foreign stations at as short intervals of time as possible.

If there is any one here who objects to the soldier's clothing as a cause of disease, let him exert himself to bring about a reform in that respect. If any man thinks that the food of the soldier is monotonous, and the means of cooking it insufficient, let him do all he can to promote a more rational state of things. Do not let it be said that, whereas the poor in our lodging-houses can cook their food as they please, the British soldier is condemned (as far as the barrack-kitchens are concerned) to a nauseous monotony of diet. But to come to more important matters. If any one thinks that night-duty is the cause of the mortality of the soldier (and with the facts I have brought forward respecting the Fire Brigade and the Police staring him in the face it is impossible to allege that night-duty as such is fatal to life), let him find out what unnecessary accompaniments there are which make that duty as performed by the soldier injurious, and then let him exert himself to set that matter to rights.

If any one thinks with me, that the mortality among the Infantry is due in no inconsiderable degree to want of proper exercise, let him agitate for improved drills. Let every soldier be taught the sword exercise; or, if it seem inexpedient to increase his drills, let him be encouraged to take every kind of manly exercise: let every barrack have a covered space, to which the soldier may retreat in bad weather, and find the means of indulging in athletic sports.

In country barracks a cricket-ground ought to be a *sine quâ non*, and I do not see why some modified system of allotments should not be carried out, so that the soldier might have the whole-

some labour of the farm or garden, with the stimulus of profit to induce him to work. If we were wise, and dared to raise ourselves above routine and prejudice in this matter, we should keep the soldier as much as possible in the condition of the agricultural labourer, whose duration of life I have shown to be so favourable.

Then, with regard to dissipation and intemperance—if it be true that the soldier is a dissipated and intemperate man, there can be no doubt that his health will suffer most seriously from those causes. Let him therefore who thinks so, do his very utmost to create and bring into play the largest possible amount of counter-attractions to the temptations to dissipation and intemperance which are known to assail the soldier.

But if any one thinks, as I do, that the first and greatest cause of the high mortality of the soldier is the wholly insufficient space allotted to him in barracks and in hospitals, then let him give his whole heart and soul to this vital matter. Let us hear no more about the ventilation of the present buildings; let us have no pottering experiments to bring fresh air into these narrow spaces. You cannot safely and efficiently ventilate them. But let us do all we can, individually and collectively, to cause the Legislature of this country to make a large and liberal vote of money. It is a mockery to attempt to do anything without it. We want the money from the House of Commons; and if any man thinks that the money is not to be had, it is for him and for us to take those steps by which the House of Commons may be brought to a sense of its duty.

Lastly. If there is any man here so entangled in the meshes of red tape that he cannot stir himself—so tightly bound in the fetters of routine that he cannot move till released by precedents, I will give him precedents. I tell him to look at the case of the sailor. For three quarters of a century, as I have already reminded you, the condition of the sailor has been in constant course of improvement. His case ought to be precedent enough; but if you want a case of such convincing cogency that no man of common humanity and common sense will dare to gainsay it, I will give you the case of the prisoner.

Three quarters of a century ago, also, John Howard brought

before a Committee of the whole House of Commons (not a small Committee like that whose Report we have been considering, but a Committee of the whole House) facts relating to the condition of the prisoner, bearing, many of them, a much closer resemblance than it is pleasant to think of to the barrack revelations of this Report; and the House not only gave him a vote of thanks, but that very year passed two Acts which liberated the poor prisoner (for he was often a debtor merely and not a culprit) from the evils under which he was suffering—from illegal fees on the one hand, and from the perils of the gaol-fever on the other.

But if any man is sceptical as to the reality of sanitary science, and the power given to us of preserving health by simple means, I would ask him to go back to that same period (three quarters of a century ago) when Captain Cook demonstrated, by the example of his voyages round the world, that the sailor's life might be preserved from scurvy, and the other fatal diseases which afflicted him. I would remind him how triumphantly John Howard proved that gaol-fever might be rooted out by the same means which we are now invited to apply to our barracks; and how Jenner proved to demonstration that, if men would but consent to use the boon which Providence had enabled him to place at their disposal, the small-pox might be driven from the face of the earth. Such cases as these ought to satisfy the most sturdy stickler for precedents. Three such cases, occurring as they did in the same quarter of a century of our eventful history, would be enough in themselves to constitute the glory of any nation but this. I say that you have precedents enough. The sanitary history of the army itself abounds in them. But if we must have another precedent, we shall find it ready to our hands in the contrast afforded in the Crimea between the frightful effects of negligence, carelessness, and incompetency in the management of affairs, and the happy state of things brought about by their opposites.

And now I shall take the liberty of addressing you in the language of entreaty. I do beseech you, by the glorious military history of England; by all that our soldiers have done and suffered for us in times past; by the triumphs and trials of the Crimea and of India;—I entreat you by your recollections of the heights of

Alma and Inkermann, of the plain of Balaklava, of the trenches of Sebastopol; by the siege of Delhi; by the defence and relief of Lucknow—but, above all, by the recollection of that scene on the deck of the burning "Sarah Sands"—and, above and beyond all, by that sublime scene on the deck of the sinking "Birkenhead," before which the noblest deeds of ancient heroism sink into insignificance, and to which the glorious annals of Greece and Rome afford no parallel,—I entreat you not to leave this place with hearts untouched, and resolutions half formed;—I beseech you to join hand and heart in one great effort to obtain justice for the British soldier!

For myself I must say that I did not come here simply to state facts and figures, and offer explanations of them. I did not come here merely to solve a difficult problem in sanitary science. I cannot consent to view those figures as mere lifeless sums in arithmetic. I know that every unit represents a scene of individual suffering—a death by fever, cholera, or consumption—which it was our duty to have rendered unnecessary. I came here for a very different purpose. Just as men with their hearts full of private sorrow seek a solitude wherein to weep, so I, with a great public grief pressing heavily upon me, have chosen this time and place to give vent to my feelings of surprise, sorrow, and indignation, that in the middle of this nineteenth century, in this year 1858, such a Report as the one which now lies upon your table should have been possible. In this matter, if in no other, I have obeyed the dictates of my conscience—Liberavi animam meam. I have paid the first instalment of my debt of gratitude to the noblest and bravest army that ever rallied round the standards of a careless, indifferent, and too often ungrateful, nation.

APPENDIX.

TABLE I.—BARRACKS COMPARED WITH WORKHOUSES, MODEL LODGING-HOUSES, AND PRISONS.

Least space, England, before 1847			147
Ditto	Ireland	ditto	158
Ditto	Scotland	ditto	240
Ditto	London	ditto	331
Average	London	ditto	400
Ditto	Ireland	ditto	400
Ditto	Scotland	ditto	432
Ditto	England	ditto	447
Least space, England, since 1847			270
Ditto	Ordnance Rules, 1851		400* / 450
Greatest space	ditto	ditto	500
Least space recommended (Mr. Sidney Herbert's Commission)			600
Scotch Workhouses			480
Dormitories, Model Lodging-houses, 1848			542
Prisons at Pentonville, with Ventilation			900

* 400 cubic feet is stated as the minimum in the Appendix to the Report, but 450 cubic feet is often mentioned as the Ordnance minimum, and for that reason is here inserted.

TABLE II.—BARRACKS, 1847.

Number of Returns.	Barracks.	Cubic Space. Maximum.	Minimum.	Mean.
30	Cavalry	1052	174	470
30	Infantry	536	219	382
	Difference			88

Cavalry Barracks more spacious by nearly one-fourth (23 per cent.)

TABLE III.—NEW BARRACKS SINCE 1847.

Number of Returns.	Barracks.	Cubic Space. Maximum.	Minimum.	Mean.
9	Cavalry	729	486	613
35	Infantry	682	425	512
	Difference			101

Cavalry Barracks more spacious by nearly one-fifth.

TABLE IV.—INFANTRY BARRACKS (LONDON).

—	Cubic Space.		
	Maximum.	Minimum.	Mean.
1847	429	285*	371
Built since 1847	607	426	489
	Difference . .		118

* Temporary Barracks.

TABLE V.—CUBIC SPACE IN NEW BARRACKS SINCE 1847.

—	Cavalry.	Infantry.	Difference.
Preston	683	544	$139 = \frac{1}{4}$
Sheffield	654	605	$49 = \frac{1}{12}$

TABLE VI.—MILITARY AND OTHER HOSPITALS, 1857.

—	Cubic Space.		
	Maximum.	Minimum.	Mean.
10 London Hospitals	2426	800	1472
20 Provincial Hospitals	1625	653	1075
5 Naval and Marine Hospitals . .	1340	752	1014
46 Military Hospitals	1143	400	655

Evening Meeting.

Monday, March 15th, 1858.

Colonel the Hon. JAMES LINDSAY in the Chair.

NEW MEMBERS.

The Chairman announced that 51 Members had joined the Institution since the 1st January.

LIFE MEMBER.

Colonel The Marquis of Downshire, Royal South Down Militia.

ANNUAL SUBSCRIBERS.

Hamley, E. B. Lt.-Col. R.A.
Wilson, John J. Capt. R.E.
Le Patourel, H. Lieut. Roy. S. Glo'ster Mil.
Priaulx, Jas. Col. Roy. Guernsey Mil.
Langley, Geo. Colt, Col. A. A. Gen. Roy. Marines.
Stephenson, B. C. Ens. 2nd Roy. Mid. Rifles
Torrens, R. H. Cornet 2nd Drag. Gds.
Halkett, Jas. Lt.-Col. Colds. Gds.
Boyle, Hon. W. G. Bt. Maj. Colds. Gds.
Fairfax, T. E. Lieut. Gren. Gds.
Nugent, E. C. Lieut. Gren. Gds.
Jarrett, C. B. Lieut. Gren. Gds.
Byng, Alfred M. Lieut. Gren. Gds.
Cholmeley, H. H. Lieut. Gren. Gds.
Clarke, C. M. Ensign 57th Regt.
Boycott, E. E. D. Ens. 21st R. N. B. Fus.
Pearson, R. L. O. Bt. Maj. Gren. Gds.
St. George, J. Colonel R. A.
Dering, C. E. Lt.-Col. East Kent Mil.
Inglis, Wm. Lt.-Col. 57th Regt.
Holworthy, E. J. Maj. 14th Regt.
Ross, A. E. Capt. 7th Royal Fus.
Chapman, W. H. Capt. Leicester Mil.
Hamilton, A. C. Lieut. R.E.
Leyland, T. Lieut. 2nd Life Gds.
Forbes, E. Capt. 1st Roy. Surrey Mil.
Hinchingbrook, Viscount, Lieut. Gren. Gds.
Fludyer, A. Lieut. Gren. Gds.
Williams, L. Lieut. 5th West York Mil.
Keane, Hon. H. F. Maj. R.E.
Molyneux, Edmund, Cornet 7th Drag. Gds.
Minet, Chas. W. Esq. late West Kent Yeomanry
St. George, Jas. Capt. Barrack Master
Jordon, W. J. Captain H. A. Company
Horsey, A. de, Capt. R.N.
Stephens, F. S. M. Lieut. 2nd Mid. Roy. Rifles
Heneage, E. Lieut. 1st Life Gds.
Bruce, G. B. Lieut. 1st Life Gds.
Phillips, B. T. Maj.-Gen. Lieut. Roy. Body Guard.
Lennock, G. J. Capt. Dumfries. Mil.
Ewart, H. P. Lieut. 2nd Life Gds.
Kennedy, C. H. late Lieut. 98th Regt.
Marsh, W. D. Lieut. R.E.
Denison, S. C. Dep. Judge Ad.-Gen.
Reid, David, Capt. 4th King's Own Regt.
Norris, G. G. Ens. 6th West York Mil.
O'Brien, R. S. Maj. Staff Officer of Pensioners
Pakington, Sir John S. Bart., First Lord of the Admiralty
Bromley, R. M. Acct.-Gen. of the Navy
Dobie, John, Surgeon R.N.

The Chairman said that he had the pleasure of informing the Meeting that several Members had increased their Subscriptions from Ten Shillings to One Pound, and also that others had given Donations of various amounts, viz.:—

INCREASED SUBSCRIPTIONS.

	£.	s.		£.	s.
Hamley, E. B. Lt.-Col. R.A.	1	0	Codrington, H. J. Rear-Adm. C. B.	1	0
Skipwith, G. Maj. Dep. Batt.	1	0	Bigge, W. M. Lt.-Col. North. Mil.	1	0
Randolph, G. G. Capt. R.N.	1	0	Edwards, Peter, Maj.-Gen.	1	0
Jervoise, W. F. D. Maj. R.E.	1	1	Kennedy, J. C. Col. Assistant Quartermaster-Gen.	1	0
Hart, H. G. Lt.-Col. unatt.	1	0	Carnac, J. R. Capt. R.N.	1	0
Tyler, Sir Geo. M.P. Rear-Adm.	1	0	Paulet, Lord F. Col. Colds. Gds.	1	0
Sturt, C. N. Capt. Gren. Gds.	1	0	Wigram, J. R. Capt. late Colds. Gds.	1	0
Kennedy, J. P. Col. late 42nd.	1	0	Craufurd, J. R. Maj.-Gen.	1	0
Sheil, Sir Justin, Col. K.C.B.	1	0	Seymour, W. F. Lieut. Colds. Gds.	1	0
Dolby, J. E. A. Capt. late N. York Rifles	1	0	Bromley, R. M. Acct.-Gen. R.N.	1	0

DONATIONS.

	£.	s.		£.	s.
Gascoigne, F. C. Trench, late Capt. 66th Regt.	20	0	Macdonald, A. Col. (Life Member)	1	1
Blamire, Charles, Capt. 99th Rt.	5	0	Narrien, John, Esq. F.R.S. (Life Member)	0	10
Yorke, P. J. Col. (Life Member)	4	0	Monro, D. A. Maj. late 12th Lancers (Life Member)	1	0
Lindsay, Hon. Jas. Col. Gren. Gds.	20	0	Vyvyan, R. H. S. Lieut. Cornwall Rangers (Life Member)	1	0
Jefferson, R. Capt. late Ceylon Rifles	1	0	Herbert, Sir Thomas, K.C.B. Admiral (Life Member)	10	0
Packe, Edmund, late Capt. R. H. Gds. (Life Member)	1	0	Dobie, R. Surgeon, R.N. (Life Member)	0	10
Pollock, Sir Geo. Gen. G.C.B (Life Member)	1	0			

PRESENTS—LIBRARY.

(*The Donors' Names in Italics.*)

CIVIL ENGINEER, OR ARCHITECT'S JOURNAL. No. 286, 287, 288. *The Editor.*

ATHERTON (Charles), Esq. Steam-Ship Capabilities. 8vo. Woolwich, 1854. 2nd Edition. *The Author.*

ROYAL SOCIETY (Proceedings of). Vol. IX. No. 28. *The Society.*

LEEDS PHILOSOPHICAL AND LITERARY SOCIETY. Annual Report of the Leeds Philosophical and Literary Society for 1856—57. Pamph. Leeds, 1857. *The Society.*

GARDINER (Sir R. W.) General, K.C.B. Comments on the question of Legislative Military Responsibility. Three Copies. 8vo. London, 1858. *The Author.*

ROWELL (G. A.) Esq. An Essay on the Beneficent Distribution of the Sense of Pain. Pamph. 8vo. Oxford, 1857. *The Author.*

ROWELL (G. A.) Esq. An Abstract of a Paper on the Storm of September 22nd, 1856. Pamph. *The Author.*

ASHMOLEAN SOCIETY (Proceedings of), 1855. *G. A. Rowell, Esq.*

HOSPITAL. The History and Design of the Foundling Hospital, Guildford-street, Russell-square. 8vo. London, 1858. *The Committee.*

LANGROIS BOILLOT (Joseph). Modelles Artifices de Feu, et divers Instrumens de Guerre, avec les moyés de s'en prévaloir. 8vo. 1798. *Capt. W. F. Lendy.*

MORTARS. Experiments connected with the Comparative Strength of Iron used in the Manufacture of Mortars. Pamph. 8vo. Woolwich, 1857. *Lord Panmure.*

ROYAL AGRICULTURAL SOCIETY (Their Journal). Vol. XVIII. Part. 2, No. 11. *The Society.*

ESTE (M. L.) Esq. M.D. Facts respecting the Drainage of London, and the Pollution of the Thames. Two copies. Pamph. 8vo. London, 1858. *The Author.*

ALMANAC. Science of Art Almanac for 1858. *The Committee of Council.*

ATLAS. A new Genealogical, Historical, and Chronological Atlas, 1807. *Major Stuart, late 7th Fusiliers.*

MILITARY DICTIONARY. A new Military Dictionary, or Field of War. *Major Stuart, late 7th Fusiliers.*

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Models.

1 Elongated Rifle-Shell for conveying liquid fire.
2 Railway Danger Signals. *Capt. John Norton.*
10 Models of Shot, Shells, and Carcases,
13 do. of Cartridges and Covers,
5 do. of Tubes,
5 do. of Caps,
4 do. of Rockets,
5 do. of Lights,
2 do. of Portfires,
13 do. of Fuzes. } *Secretary of State for War.*

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Russian Man-of-War, which was taken in the Dock-yard at Sevastopol. *Lent by Rear-Admiral Sir S. Lushington.*

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Great Britain's Coasting Pilot, in 2 parts, 1774.
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French Atlas. *Lord Radstock.*

MUSEUM.

Armoury.

A Lance, which belonged to Colonel the Hon. Lincoln Stanhope, and was carried by him when serving with his Regiment, the 17th Lancers.
James Ewen, Porter.

Russian Musket and Bayonet, taken by himself at Sevastopol.
E. Bartholomew, Boatswain H.M.S. Fisgard.

Two Russian Helmets, taken in the Crimea. *Rear Admiral Milne.*

1 English Cross-Bow.
1 Seikh Carbine.
1 do. Bow.
1 do. Quivers and Arrows.
1 do. Canister Shot.
1 do. Lance.
2 do. Powder-Horns and Pouches.
2 do. Swords.
Mr. Money.

Naval.

The Main Truck of the L'Orient, blown up at the Battle of the Nile, 1st August, 1798. *Lent by the Lords Commissioners of the Admiralty.*

MISCELLANEOUS.

2 Gilt Glass Tesseræ, from the Dome of the Mosque of St. Sophia at Constantinople. *W. D. Kerr, M.D., R.N.*

CHAIRMAN'S ADDRESS.

BEFORE the business of the evening begins, this being the commencement of our Evening Meetings and Course of Lectures for the season, I trust you will permit me to make a few observations with respect to the objects we have in view. Last year, when I had the honour of addressing you, I touched upon various topics relating principally to Finance, and to the state of our Members, and the means of increasing their number. At that time we were little aware of the cloud that was about to break over us, in the shape of the Mutiny of the Sepoy Army. The effect of that Mutiny has been very injurious to our interests, as it has withdrawn from our

shores a large mass of officers from whom we had fair hopes of recruiting our numbers. While, therefore, I cannot congratulate the Members on any great improvement in financial position as regards an increase of Members, yet the receipt of Government support gives us a prospect of security for the future, and has enabled the COUNCIL to take a step of the greatest importance to the interests of the Institution, in the publication of a Journal of our proceedings. In consequence of the grant, the COUNCIL considered that if the Institution was ever to take a prominent position as a Scientific Establishment, that vigorous measures should be at once, and without delay, adopted, to put the Museum into complete classical order—to dispose of duplicates and articles of no interest or use, and to organise it in a manner so as to exalt its character, create an interest in the public, and be useful and instructive to the Members. We have carried these views out, and are now in a position to advance the interests of the Institution still further, if supported by the Services; and, whether as an Institution promoting professional science, or as a Museum of professional interest, it was never yet so worthy of their support as it is now. To do this effectively, the COUNCIL ought to have at their disposal an income of not less than £2,000 a year, independent of Government aid; and when it is recollected that there are not less than 12,000 officers in the several Military Services, this sum does not appear large.

We seek to make the Institution useful to the Members, useful to the Services, and by that means useful to the public. Our efforts have been, as far as we have gone, successful; and they have received the approbation of our Members, and have been noticed in very complimentary terms by those severe critics—the Press. We have put before the Members what I trust they consider a good bill of fare of Lectures and Evening Meetings, when subjects of great interest will be explained by gentlemen of scientific acquirements; these will be, through the medium of the Journal, transmitted to our Members in every part of the world, by which they will benefit by our proceedings here.

We have thus gone far to establish ourselves in the eyes of the world, and already have met with encouragement, by the accession of new Members: we have suffered from not being known, and the

more we can show officers of the Army and Navy that we are working for the public good, the more will a feeling of professional pride in our establishment extend itself.

We are, however, merely carrying out now what was the original intentions of the founders of the Institution, in 1831. I will read you a short paragraph which occurs in a speech at that time: the objects of the institution were thus briefly described—"For the promotion of the interests and development of the energies of the two Services; the strengthening and knitting together friendship between the Services, which a common object equally beneficial to both cannot fail to produce. For the improvement of art and science in the military profession, by inventions, models, and drawings, and collections of military relics and curiosities. For the study of fortification and books, and for lectures on professional subjects. The subscription is small, and the object great." Such were the aspirations of the distinguished veterans of the French War in both Services. How is it that it failed to produce the expected result? Their plans were received with enthusiasm: officers of the Line and Navy poured in as voluntary subscribers; donations arrived to such an extent that there was no room for them; Local Committees of Members sprung up in every part of the world to further its interests. But enthusiasm requires being fed—it lasts but a short time—it must be followed by some real and substantial benefit, which through reason commands the support which enthusiasm commenced. The founders were unable to carry out their views, by circumstances beyond their control; and, though they became rapidly rich, they were unable for many years to get a building sufficiently capacious for their objects, and the capital of the institution was spent in the purchase of a house, and in building this theatre. By this time the strong feeling in its favour had departed, a new race of officers had sprung up, and at the very moment we were in a position to carry out the original object, we were poverty-stricken, laden with burdens of rent and rates, and it required the greatest caution to maintain our position. But we shall rise again, I trust, and already there appears a good time coming; and, although we may not be able to excite the former enthusiasm, yet when officers see that the Institution is useful,

practical, and interesting, there is reason to hope for their willing co-operation.

Amongst other improvements we are establishing a Topographical department under the auspices of Colonel Alcock; and it is gratifying to observe that General Cameron, the President of the Council of Military Education, and Sir Edward Cust, the author of the "Annals of the Wars," find our valuable Military Library of essential service to them in promoting their several objects.

We are most anxious that Members should introduce their friends to our Evening Meetings, and that they should take part in any discussions which may arise on the merits of inventions, or on the subjects upon which papers may treat. We are anxious to promote discussion at Evening Meetings, in order that by difference of opinion, and the expression of practical views, professional information may be extended.

In the Navy, scientific attainment has been propagated by the necessity which exists for knowledge and experience in the art of navigation, and our young men must undergo a severe naval education, without which they cannot be permitted to become officers in that service. But in the Army the case is different; there is not in the younger branches of this service that individuality of action so common in the Navy, and it had therefore been considered that officers might become sufficiently accomplished in professional knowledge by the time they arrived at regimental command. But of late years this system has been properly altered, and now, both before and after joining, a certain standard of general and professional knowledge is required. We propose to have in this Institution specimens or models of everything that can illustrate the profession, and which may make officers acquainted with all that may be useful to them. We seek by obtaining the services of officers of practical experience to extend information upon professional subjects, both to those who attend in this theatre, and also by means of the Journal to those whose service prevents them from being present. We hope by carrying out these views to render this Institution a public benefit, worthy of the professions and the country.

CUNNINGHAM'S SYSTEM OF REEFING SAILS FROM THE DECK.

THE Lecturer, in tracing the history of sails to their earliest origin, stated that the first mention of sails is in Isaiah, at the 33rd chapter (B.C. 712), "they could not spread their sails." And that in the 27th chapter of Ezekiel, 7th verse (B.C. 588), there is a particular description of the sails of the ships of Tyrus, which are stated to have been formed of "fine linen with broidered work from Egypt." He considered however that, although these were the earliest actual mentions of sails, they must have been in use nearly three centuries before the earliest of these dates, as with reference to the ships of Solomon's navy alluded to at the 9th chapter of 1st Kings, 26th verse, it was not probable these ships could have accomplished so long a voyage as from the upper part of the Red Sea to Ceylon (for such the "Ophir" of the Holy Volume is supposed to be) and back without the use of sails. The Lecturer also alluded to the ships of the Greeks and Carthaginians as having used sails; the vessels of Ptolemy Philadelphus being described as having had three masts. One of the oldest genuine representations of an early vessel of the Christian era is to be found in the celebrated tapestry in the cathredral at Bayeux in Normandy. With reference to the question of the manner of setting the sails of the early vessels, the Lecturer particularly referred to the interesting description of St. Paul's shipwreck in the 27th chapter of Acts, in which the mariners are described as "hoisting up the mainsail." The Lecturer then traced the progressive improvements in the equipment of ships aloft from the reign of Henry III. upwards, to the present date. In the reign of Edward IV. the ships of war had four masts, the sails on the two foremost masts being square, and those on the two aftermost ones of a lateen description; indicating that at this period sailing on or close to the wind was known.

Towards the commencement of the 17th century, a remarkable change was made in the arrangement of the sails; upper sails were now used, which doubtless were the origin of the modern "topsail." The rigging too of the ships of this date was more in

accordance with those of the present day. Towards the middle of the 17th century a still further improvement was made, and those sails which we now call top-gallant-sails were first adopted on a large ship—what must have been the wonder of the age—the "Sovereign of the Seas." This ship had four masts, and her two fore masts were fitted with top-gallant-sails, and the two aft, or mizen masts, had fore and aft sails upon them. This vessel was afterwards rebuilt, and in 1684 another picture represents her with three masts, and altogether the arrangements aloft appear to have been very similar to modern ships. The Lecturer considered that it was about the end of the last century that studding sails or steering sails were introduced, together with those extra lofty sails, such as royals, skysails, &c. The Lecturer then proceeded to consider the arrangements of our forefathers for adjusting the extent of the sail area to the force of the wind. He considered that in the early vessels this was simply done by the number of sails set; thus, when upper or topsails were used, when the force of the wind required a reduction of sail, the topsails were lowered, and the ship sailed under the lower sails, which again were respectively taken in as the gale increased, &c. Although however this might do with the small ships years ago, when ships of the size and character of the "Royal Sovereign" appeared, it was necessary to make further arrangements for the adjustment of the sail power, and he considered that it was about this period that the plan of reducing the area of the topsail by reefing was adopted.

The earliest description which the Lecturer had been able to obtain of reefing the square sails of ships was in an old edition of a work entitled "The New Practical Navigation, by John Hamilton Moon," in which is a diagram of a first-rate man-of-war, with the various ropes carefully numbered and lettered, and the arrangements for reefing the topsails are identical with modern usages. The Lecturer illustrated the process of reefing topsails in the old or ordinary method by a very perfect model of a topsail; and he then proceeded to point out the imperfection of the mode of reefing on this plan;—the care and skill which it required; the necessity of having skilled seamen to execute it properly; the difficulties attending the operation under certain circumstances. He then

pointed out the danger of the operation—the frequent loss of life which it occasions, quoting some startling facts from the New York Daily Times, in which it stated that no less than one thousand seamen are annually lost in the Mercantile Marine of America by falling from aloft in reefing.

The Lecturer then passed on to the subject of his invention for reefing from the deck, illustrating it by a working model.

His plan is to roll the sail up in the yard, which is fitted to turn round in the sling-hoop and yardarm-hoops for that purpose. He employs the weight of the yard as the motive power for producing rotation to it. This is in fact the great principle of the invention, and it has been by obtaining this self-acting process that he has been enabled to carry out his object so effectively. The following extract from a work published by the Lecturer very clearly explains the principles of his Invention :—

" The principles of my Invention are, that I cause the yard to be so fitted as to turn round in the sling-hoop and the yardarm-hoops, and that I reef the sail by rolling it up in the yard. Also that I collect the weight of the yard, sail, and attachments, and employ it as power to produce the necessary rotation of the yard, and consequent reefing of the sail ; thus, in fact, constituting it a self-acting process. This last prominent principle in the invention may moreover be viewed as an economizer of power ; and can be further elucidated by the consideration, that when a topsail is suspended at the mast-head, the weight of the yard, sail, &c. represents power collected on the topsail-tie, and which power is capable, by mechanical arrangement, of being applied to the production of either rectilinear or rotatory motion. Upon the old system of working topsails, this power is expended or lost every time the topsail is lowered, without being turned to account. Now upon my principle, I economize this power, and apply it to produce the necessary rotation in the yard for reefing the sail : and, further, this power is not only exercised to roll up or reef the sail, but by an arrangement of my principle, I also obtain a certain reciprocal assistance from it in hoisting or unreefing the sail."

It appears that the inventor has several methods for rotating the yard. He takes ropes or bands of suitable length, and winds them

round the yard ; one end of these ropes or bands is confined to the yard, and the other end aloft. When the yard is lowered, the weight of the yard is received on these ropes or bands, the unwinding action of which necessarily produces rotation to the yard. He also slings the yard in the bight of the chain-tye, which is so arranged as to form double haulyards. The chain lies in an indented grooved boss fixed to the yard, which rotates within sling-hoops or collars upon each side of the boss, and which collars are connected to the parrall by a double joint and drop-bolts. When the foremost part of the chain is kept fast, and the others lowered or slackened, the yard is "parbuckled" down, and consequently rotated, rolling up the sail as it descends. Again, when the same part of the chain is hoisted upon, the effect is to parbuckle the yard up the mast, and so unroll the canvas. To enable the sail to clear the centre fittings, it is divided down the centre to a suitable distance, and the edges of the aperture are roped in a peculiar manner, upon which travellers are disposed at intervals, having a narrow slit at one end to allow the sail-cloth to pass freely through. These travellers are connected to each other in pairs across the sail by straps, and upon each side of the sail a cloth of canvas is laid which is attached to this system of travellers, and connect at the upper part to a swinging iron forming part of the centre fittings. This forms what the inventor terms "the bonnet." It is in fact a valvular cloth for filling up the aperture formed in the sail, and is self-acting. The yardarms revolve within yardarm-hoops or collars, upon which is a block for the top-gallant sheets, and to which also the lifts and braces are attached. Stretching from lift to lift is a spar, which is termed the "chafing-spar," the intention of which is to preserve the rolled-up sail from the friction of the lee rigging. This spar is connected to the yardarm-hoops, and lashed to the parrall. The top-gallant-studding-sail-booms are also carried upon this spar. It was with a yard upon this last-described arrangement that the Lecturer illustrated his explanations. He stated that this was the usual mode of fitting the invention.

The Lecturer stated that his invention was now in use on board upwards of three thousand ships, embracing the noble clipper-ships of 2000 tons register, and the humble coasting schooner

of 50 tons. The benefits which navigation has derived from the invention appear to be very great: some of them may be thus enumerated. The topsails of the largest or the smallest ship can always be reefed and unreefed by the watch on deck. Indeed in many cases the operation has been performed by a couple of men. The ability which the invention affords to the commander to carry on to the last moment, and again make sail on the least falling of wind, furnishes the means of making better passages than on the old plan, when sail is often taken in prematurely, and not applied again when it could be with benefit. Some extraordinary voyages have been made by ships fitted with the invention; one has been particularly recorded in the case of the ship Imogene, which performed the voyage from Algoa Bay to London in forty-five days.

It has been found of incalculable advantage to ships which have had their crews reduced by sickness, desertion, or other causes. A variety of extracts from letters received were read, all testifying to the advantages of the new system of reefing, a few only of which are subjoined. The Commander of the ship Hurricane, of 1608 tons register, reports having navigated his ship from Hong Kong to San Francisco with only twenty-five lascars and three European steersmen. So much regard, too, need not be paid to the skill of the crew, as the untrained seaman is as efficient as the real sailor in reefing on this plan. This is most important to the mercantile marine, as it is often most difficult to procure an efficient crew. During the late war, and at a time when it was almost impossible at some of our sea-ports to obtain sailors, a large ship left Glasgow rigged on the Cunningham system, with a large proportion of her crew composed of brickmakers! She could not possibly have done this if fitted in the ordinary method.

It has been found that the sails wear much longer than on the old plan. The brig Speck, of Portsmouth, has now in use a topsail which was made for her seven years ago, and has been in use ever since.

The Cunningham system has been found of great service in ice and snow. Several of the Greenland ships from Hull are fitted, and the Fox discovery vessel has her topsail on the plan.

Time would not admit of the Lecturer's quoting *in extenso* the

large number of commendatory reports which he has received, but it may be interesting to make some brief extracts from the reports from commanders of ships experienced in the use of the invention.

Mr. Le Bass, the Commander of the barque Glory, in a letter dated 25 Feb. 1858, states that he has been three voyages with the invention, and the fore-topsail, which was first fitted, is still a good sail. That since he has had the plan he has sailed with two hands less. That he carried away his main-topsail-yard of the Lizard, and in four hours had another one across gear refitted, and sail set. That ships fitted with the plan evidently get the pick of the men, as the seamen come forward for ships so fitted in preference to the old plan.

Mr. Fry, Commander of the brig African Queen, employed on the west coast of Africa, states, in a letter dated 9 February, 1858, that he found his topsails more convenient in the tornadoes; also, in bringing up for a tide, lowering the topsails close reefed. On one occasion, when at anchor, a gale suddenly came on right on shore; by being able to set his topsail instantly close-reefed, he saved his ship. That he found there was no necessity, as on the old plan, to shorten sail at night, because the weather might look threatening, as sail could always be taken in.

Mr. Adey, Commander of the ship Delia, states that he found his topsails invaluable in the Gulf of St. Lawrence, on reaching the ice, by enabling him to reef and haul to the wind at the same time.

Mr. Hopkins, of the barque James Montgomery, states that on one occasion he had a whole main and single reefed fore-topsail at 9 P.M., the wind increased suddenly, and with no one to assist him, he singly reefed the main and double reefed the fore-topsail in less than ten minutes.

Mr. Weeks, of the ship Kingston, (900 tons,) reports that on one occasion, off the Cape of Good Hope, the foot-rope of his fore topsail gave way and split the sail; he found no difficulty in sending it down and bending another, *setting it close-reefed;* "the operation being done as quickly as on the old plan."

Mr. Greig, of the ship Shandon, fitted with topsails, courses, and top-gallant-sails, states—"On my passage home, all our reefing

was nearly off or before the wind, but, under all circumstances, I found it to work most satisfactorily; indeed, the reefing of our topsails hardly gave me a thought, I had them so completely under my command. With the new plan there is little wear and tear, so far as the reefing is concerned. The topsails never get a shake, and there are no points to chafe the sail. I find this method very useful for our top-gallant-sails. When rolled up close down to the cap, the sail is very easily furled afterwards." In a further letter he says—"The foresail gives great satisfaction; five minutes are sufficient to reef it under every circumstance."

Mr. John Robson, of the barque Snowdon, alludes to the benefit which he has found from the topsails, his ship being a very tender ship.

Several masters of colliers report having found great benefit from the invention in running into the river Wear in heavy easterly gales, as they could, before entering the broken water on the bar, put more sail on so easily. In the great gale of September, 1852, the only ships that entered the Wear in safety were on the Cunningham system.

Mr. Prymm, of the ship Childe Harold, reports that, having been suddenly taken in a heavy gale in the China Seas, he was able to reduce sail very quickly, and he considers that he should have lost his fore and main-topsail, had they been on the old plan.

Lieutenant Du Buisson, commander of the French national steam-corvette Cocyte: "We have experienced in the icy seas all that was to be desired to test the Cunningham system. Nothing has failed, and we have always reefed rapidly and securely."

Mr. Foreman, of the Sea King, says: "But I cannot close without mentioning the excellent manner in which Cunningham's Patent Reefing Topsails have acted. They are a real blessing to every one connected with the sea. I attribute, at least, four days' saving in my passage from the power to make and take in sail so easily."

The master of the brig James Steward, in reference to a very remarkable passage which he had made, writes: "A portion of this success is due to Cunningham's Patent Topsails; by means of this admirable invention sail can be carried to the last moment. The

process can also be performed by ordinary seamen and boys as easily as by able seamen."

Mr. Robert Matthew, commanding the Earl of Marr and Kellie, says: "We were running with a strong gale, carrying on sail, when we were caught aback. With ordinary topsails I should have lost sails and spars, so sudden was the shift, but by the time our yards were swung round our topsails were close-reefed. I hope I shall never be on the old method again."

The Lecturer, having practically illustrated the description of his invention by the model which is lodged in the Museum of the Institution, proceeded to remark on the application of his system to screw steam-ships and ships of war.

With reference to screw steam-ships, he said: "The usual mode of applying steam-power to ocean steam-ships employed on voyages where trade-winds exist is in an auxiliary form. These ocean steam-ships then use their steam-power only in those portions of their voyages where calms or light winds prevail. During the other parts they use their sails only, and are, in fact, altogether sailing ships. The auxiliary steam-ship has therefore to maintain a sailing crew in addition to the engineer's staff; generally, however, the sailing crew is confined to the smallest possible number, and is not in proportion to the scantling of the yards and sails. Some of these large screw ships have masts and yards as large as line-of-battle ships, with not more than perhaps twenty seamen in the crew. The consequence of all this is, that the sail-power is not used to the best advantage. However enterprising the commander may be, whatever nerve he may possess, still the fact of having large powerful sails, and with but few men to work them, must often induce sail to be taken in when otherwise it might be carried with advantage.

"I consider, therefore, my invention to be peculiarly adapted to screw steam-ships, especially when it is applied to the topgallant-sails as well as the topsails. Here you have at once the means of enabling the commander to bring into use that portion of the crew which before were, to a certain extent, useless for navigating the ship. The cuddy servants, the landsmen, or even the passengers,

are with my system as effective as the skilled seamen, and the effect is, that the full value of the sail-power is used, and the general capabilities of the ship greatly augmented."

The Lecturer also remarked on the sensible decrease in the number of our merchant seamen, and on the deterioration of their skill. He believed that the abolition of the apprentice system had been most prejudicial to the mercantile marine as a nursery for future seamen, and, unless some means were speedily adopted to rear up seamen, in a few years the difficulty of obtaining sailors will be most serious. With these considerations it was evident that some means were urgently required for assisting in the navigation of our large merchant ships. And he believed that requirement was met by his invention. The fact of the ship Hurricane, as before alluded to, proves that ships rigged on the "Cunningham system can be navigated by much fewer seamen."

Passing to ships of war, he considered that his invention was peculiarly adapted to them. That steam had wrought such a change in the considerations connected with ships of war, with reference to foreign navies, that the necessity of maintaining a superiority in nautical skill does not now exist to the extent which it did when the evolution of ships depended on the handling of the sails alone. Our ships of war may now be viewed as mere floating batteries, the guns of which can be as well served by marine artillery, or by the artillery soldiers, as by sailors; indeed, more so, as the one is more capable of being perfected in the mechanical details of gunnery-work than the sailor. The object then is so to equip the ships as to enable them to be navigated in every way with the smallest possible number of seamen; so that in the event of any sudden outbreak of hostilities, an efficient fleet could be extemporised by distributing the seamen comprising the full complements of ships already in commission amongst a number of ships, and assisting the crew by marine artillery, or militia artillery soldiers.

There were also other considerations connected with his system which he believed to be important. The invention enables a ship of war to go into action with her sails snugly furled, yet able to be

Plate 1.

Fig. 1.

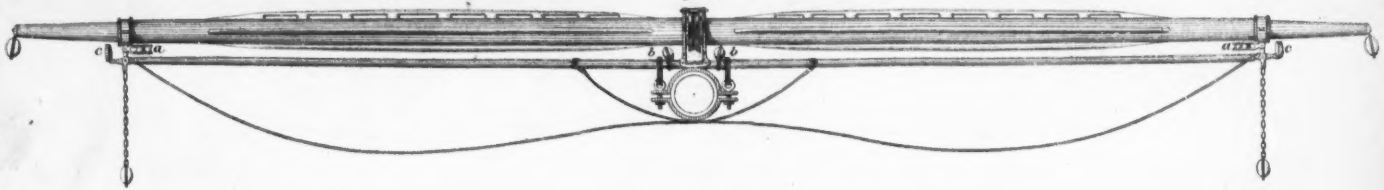


Fig. 2.

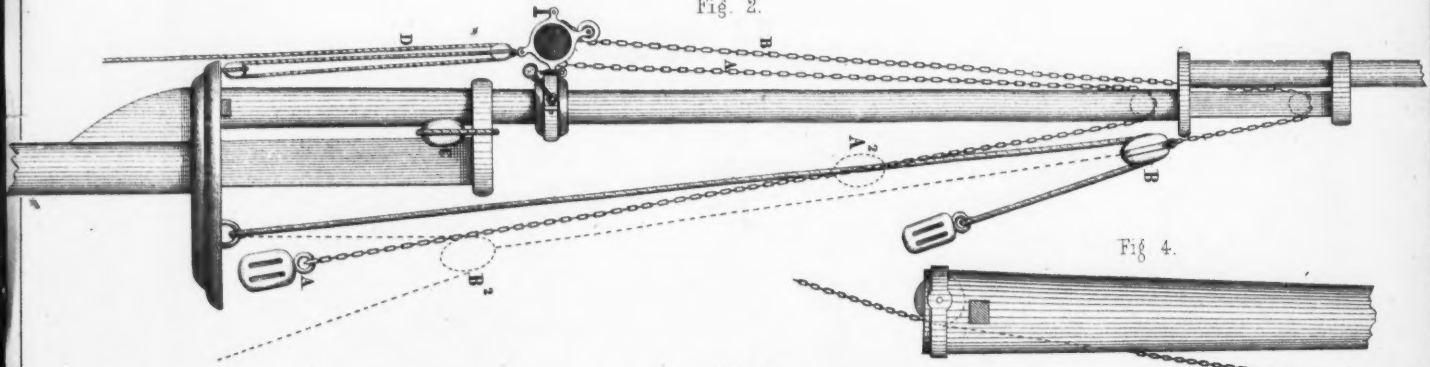


Fig 4.

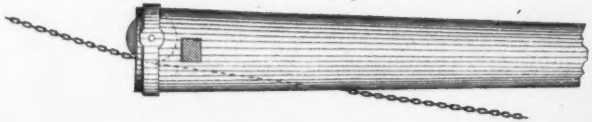
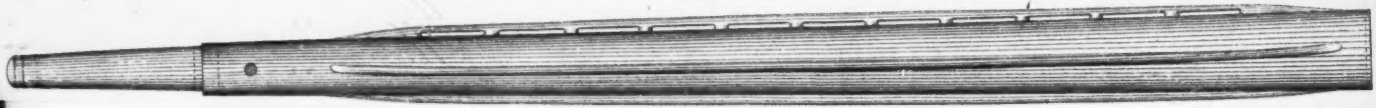


Fig. 3.



Scale ½ inch.

set from the deck without a man showing his head above the hammock nettings; while, in the event of the screw being disabled, or the ship otherwise deprived of the use of the steam-power, and necessitated to be placed under sail, it would be a vast advantage.

Regarding the practical efficiency of his invention to ships of war, the inventor remarks: "If the system succeeds so perfectly on board of the large and powerful Australian clipper ships (which are in the habit of 'carrying on' more than is even practised in ships of war, except in chace,) as to induce their commanders to seek for its application, to enable them to make better passages and otherwise to obtain benefits, there cannot be a sound nautical reason why the system should not be equally applicable and successful on board of ships belonging to the State."

General Description.

The sail is reefed from the deck by being rolled up on the yard, which is so fitted as to turn round freely in the sling-hoops and yardarm irons, a provision being made to allow the sail to clear the centre fittings. A light spar, called the "chafing-spar," is fitted abaft the yard, and secured at each yardarm, to keep the sail off the lee-rigging, when the yard is braced forward. The yard is turned round by means of its being slung in the bight of the chain-tie, the chain lying in a whelped boss on the yard.* The forepart of the tie is fitted to be a standing part, and when the afterpart is lowered upon, the yard is parbuckled round, and the sail rolled up; and, again, when the afterpart is hoisted upon, the yard is parbuckled up, and the sail unrolled. Figure 1, Plate I., shows a plan of patent topsail-yard fitted complete. The top-gallant sheets lead through the iron-blocks *a a*, and down on deck through the quarter-blocks *b b*. The foot-ropes, it will be seen, are attached to the yardarm irons and chafing-spar. The top-gallant studding-sail boom-irons are carried on the chafing-spar at *c c*, thus allowing the topsail to be reefed without rigging in the booms, should the

* There are also other methods for turning the yard, by the employment of wound-up ropes or bands. Another method also consists of rolling the sail up on a supplementary yard or spar, by which the fittings of the ordinary yard are not disturbed.

Scale ½ inch.

top-gallant studding sails be set, and the ship taken in a squall, which is an important feature.

Figure 2, Plate I., exhibits a side-view of the yard, and the lead topsail ties, &c. *A A* and *B B* are the two parts of the tie, in the bight of which, it will be seen, the topsail-yard hangs. In this drawing, there is a second sheave-hole at the mast-head through which the forepart of the tie is led, a score being cut in the heel of the top-gallant mast to allow it to come up clear,* and this plan is the one particularly recommended by the patentee. The end of the tie *B* is fitted with a runner, the standing part of which is in the top. The hoisting part *A* may be fitted with a common purchase on the end, except in large ships, when any arrangement necessary may be made.

To hoist the whole topsail, both haulyards are hauled on.

By lowering on the part *A*, the part *B* being kept fast, it will be seen that the yard necessarily turns round as it descends the topmast, and the sail is rolled up accordingly. By hoisting on the part *A*, the yard is parbuckled up, and the sail unrolled. When reefing, the sail in lowering slacks a little; this is taken up by hauling on the part *B*, so as to keep the topsail tight set. By lowering on both haulyards, the whole topsail comes down without rolling up.

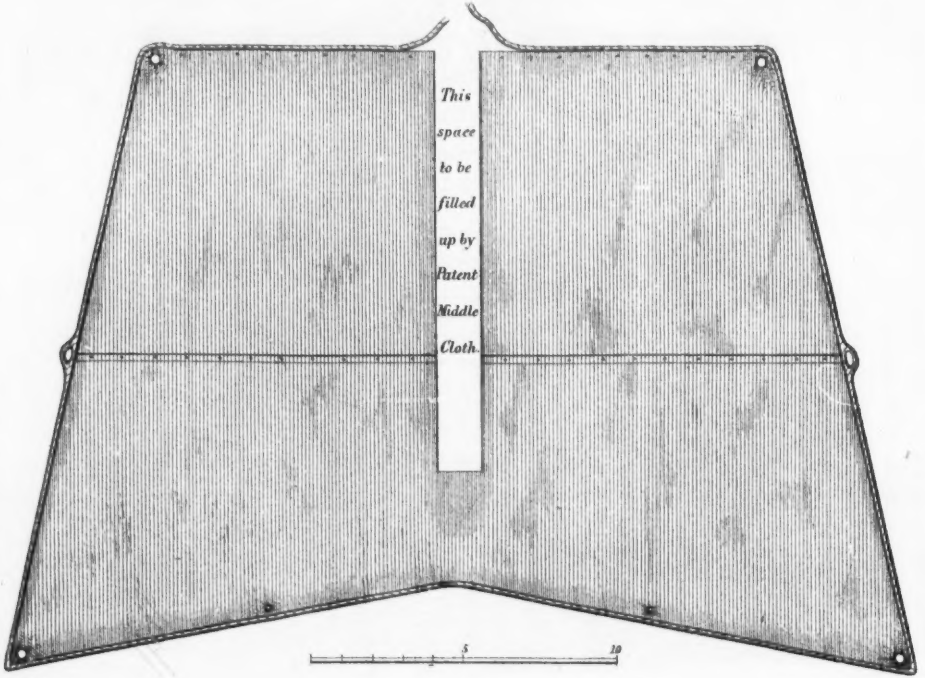
It is recommended to fit the clew-lines to the lowermast cap; *C* shows the clew-line block; and a downhaul tackle *D*, is fitted to assist the yard down in case of necessity.

Figures 1 and 2, Plate IV., shew the appearance of the whole topsail when set, and also when close-reefed.

A certain new portion of middle cloth, with the patent bonnet fitted complete to it, is supplied with the patent gear, and the sail-maker has simply to take out so much of the old middle-cloth and put in the new piece or bonnet as it is received without any alteration ; the points and cringles must be taken out, except the cringle of the close-reef and reef-tackle, which may be left. In new sails, so much of the middle-cloth will be *left out* as will take in the whole length of the patent cloth supplied.

* A roller is also let into the heel of the top-gallant mast for the chain to lie upon.

Plate 2.



Drawn by H. D. P. Cunningham.

The stray ends of the roping on the new middle-cloth are left to splice into the old head-rope. See Plate II.

In making a new yard it is not required to work out cleats at the yardarms, but the yard must be taken out full and round to the lifts, leaving a good shoulder for the friction-iron of the brace-hoop to butt against.

The yard to be "eight square" at the slings. The drawing at Fig. 3, Plate I., shows the mode of working out a yard on the Cunningham system.

For the general shape, dimensions, and arrangement of the jack-stays and battens, see Figs. 1 and 3, Plate I.

The inner head-earings of the sail are confined to the yard by hooking them over screw stud-bolts screwed into the yard (See Fig. I., Plate 3 at *A A*).

A hole of sufficient size is bored through the yardarm (See *c*, Plate 3) for the head-earing to pass through. This hole must be far enough from the lift to be quite clear of the top-gallant sheet-block.

Besides the yard, a light spar is required, called the chafing-spar (See Fig. 1, Plate I.). The intention of this is to keep the rolled-up sail off the rigging, &c., when the yard is braced up. It also carries the top-gallant studding-sail booms.

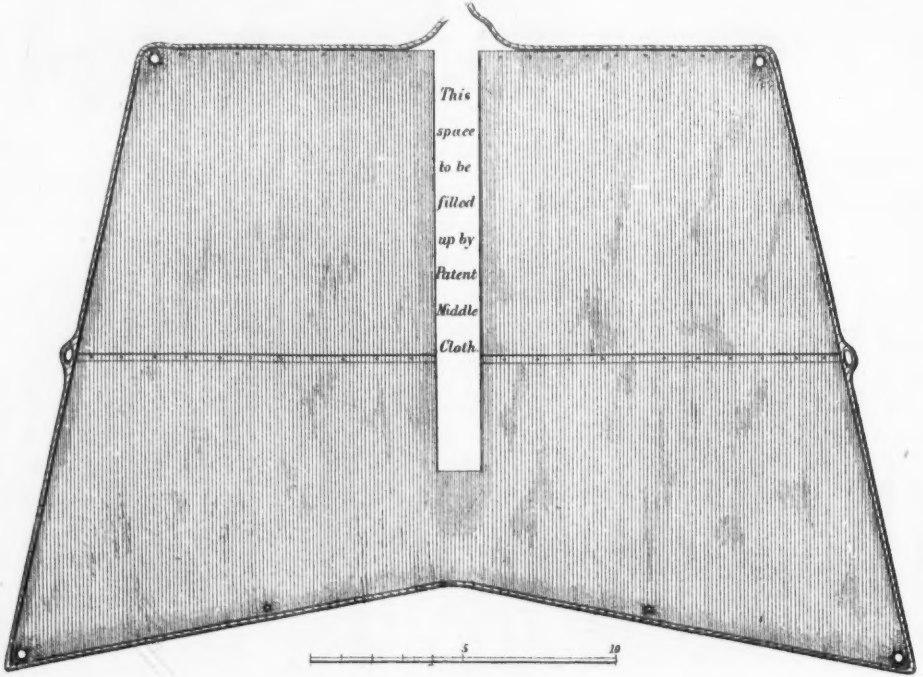
The Patentee earnestly recommends in all cases where it may be practicable that a second sheave-hole be cut in the masthead (see Fig. 2, Plate I.), and a score in the heel of the top-gallant mast for the lead of the foremost or reefing part of the topsail-tie. In fitting masts on this plan, it is necessary to have a roller put into the score in the heel of the top-gallant mast for the chain to work over, which should have an iron band to take pin of roller, and forms dogs at foot of score. (See Fig. 4, Plate I.)

Fig. 1, Plate I. shows the mode of rigging one of the Patent Top-sail Yards.

At Fig. 2, Plate I. is shown the proper length of the topsail-tie, and where the ends should come to with the yard on the cap, and the whole sail loose upon it. When the yard is on the cap with the sail close-reefed upon it, the ends of the tie will be as in the dotted lines.

After the sail has been reefed several times, the part *B* will

Plate 2.



Drawn. by H. D. P. Cunningham

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Fig. 1, Plate I. shows the mode of rigging one of the Patent Topsail Yards.

At Fig. 2, Plate I. is shown the proper length of the topsail-tie, and where the ends should come to with the yard on the cap, and the whole sail loose upon it. When the yard is on the cap with the sail close-reefed upon it, the ends of the tie will be as in the dotted lines.

After the sail has been reefed several times, the part *B* will

borrow upon the part *A*, in the same manner as the jib-purchase of a cutter. It is therefore necessary to fleet the chain occasionally by overhauling on the reefing haulyard, paying the chain under the boss, and giving back to the working part *A*.

The top-gallant sheets lead through the blocks *b b*, Fig. 1, Plate I., at yardarms, and quarter blocks, *c c*, strapped on the chafing-spar close to the suspended lashings.

It is recommended to take the clew-line to the cap, and a down-haul tackle (see *C* and *D*, Fig. 2, Plate I.), which should never be omitted, is fitted.

Instructions for Working Cunningham's Patent Self-Reefing Topsail.

To bend the sail.—Put the eyelet-holes in middle of sail over the iron bolts or studs on each quarter of the yard; secure the upper part of bonnet to the swinging-iron; then haul out head-earings, and bend the sail in usual manner.

To hoist the whole topsail.—Hoist on both haulyards.

N.B.—If the after-haulyards are hauled upon more than the foremost ones, the head of the yard will cant over and bring the jackstay under it; a little care should therefore be taken to hoist on both haulyards alike. If the jackstay should be brought under the yard, hoist on the foremost yards alone, slacking a little on after-haulyards. It is a good plan to get a turn in the yard before hoisting on both haulyards, or to rack the two parts of the tie together, which makes it a common topsail yard.

To reef the topsail.—Lower away on after-haulyards, and pull on foremost or reefing ones until the sail is set taut.

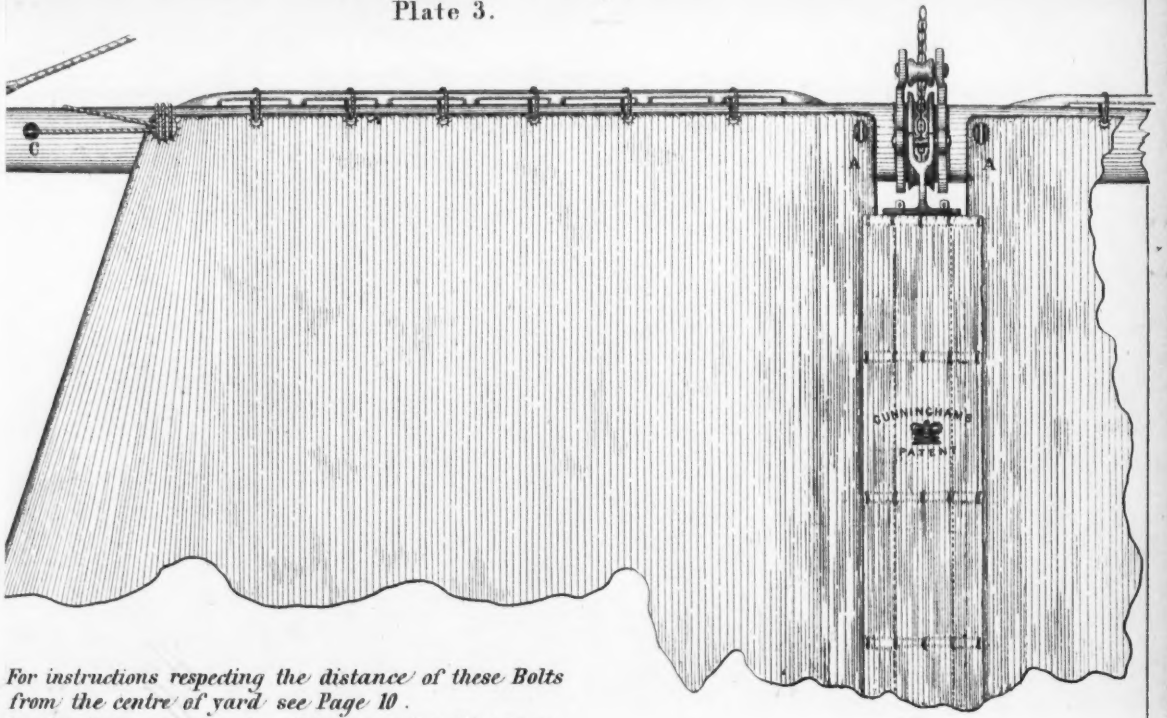
N.B.—The down-haul is provided to assist the yard down should it require it.

To shake out reefs.—Hoist on after-haulyards, slack a little on foremost or reefing ones.

N.B.—If the foremost or reefing haulyards are merely steadied in the hand during hoisting, they will slack themselves as much as they want.

To reef the sail with the yard on the lifts.—Let go the after-haulyards, and haul away on the foremost or reefing ones.

Plate 3.



For instructions respecting the distance of these Bolts from the centre of yard see Page 10.

C. For directions respecting the distance of this Hole from yard arm see Page 10.

Drawn by H.D.F. Cunningham

To shift a split close-reefed topsail, and bend and set another one close-reefed.—Pass earings through close-reef cringle, round the spur of the yardarm iron, or where the top-gallant sheet blocks are, taking care that they (the earings) are quite clear of the yard. Take, say a dozen lengths of rope that will reave through the eyelet-holes in the close-reef band, knot the ends, and reave them through so many eyelet-holes from forward to aft, so that they shall come through abaft the sail; let two or three of them be rove through the first two or three eyelet-holes from the bunt of the sail, so as to support the sail well amidships. Then clue up the sail, haul up the buntlines, and hitch the aforesaid points round the chafing-spar. The two nearest the bunt of the sail may be made fast to the eye-bolts on parrall. Disconnect the upper parts of bonnet from swinging-iron. Take a turn with downhaul, unbend sheets, keeping buntline fast. Overhaul the foremost haulyards, and haul on after-haulyards, so as to unroll the sail to head. Unbend the sail, and ease in close-reef earing, and secure all for sending down sail. Make the bending sail up so as to leave upper and lower parts separately clear, which can be done by passing strong stops through eye-holes of close-reef, previously having shoved bonnet close down to close-reef. Send sail up; haul out close-reef earings, and pass earings as before described. Support sail amidships, bend the sail, cast off stops of upper part of sail, overhaul after-haulyards, haul on foremost ones, so as to roll up sail to close-reef, a hand, if necessary, laying the leaches clear on yard. Connect upper part of bonnet with swinging-iron. Bend topsail sheets, and cast off stops of lower part of sail. Sheet home the topsail. Cast off close-reef earings, &c. Mend the reef, if necessary, by hoisting the topsail a few feet, and reefing again.

The foremost or reefing haulyards are those which come up before the yard.—The after-haulyards are those which come up abaft the yard.

Practical Hints.

The foremost or reefing topsail-tie should always be fitted with a runner, the standing part in the top.

Care should be taken that the length of the tie be according to

the drawing in Plate I. of the Prospectus. That is, when the yard is on the lifts and the sail unreefed on the yard, the runner-block on the foremost or reefing part of the tie should be at the cross-tree, and the end of the after or working part of the tie just above the top.

It is recommended to have a uniform arrangement for the ties, viz., the foremost or reefing haulyard on the starboard-side, and the after or working one on the port-side.

It will be found, after the sail has been reefed a number of times, that the foremost or reefing part of the tie will have borrowed upon the after or working part. When this is the case, a convenient time should be selected for fleeting the chain back under the yard, and so giving again to the afterpart of the tie what it had lost.

Great care should be taken to see that the chafing-spar is lashed well back, clear of the working of the chain-tie and the boss on the yard. This is very important.

A downhaul-tackle should always be fitted; the effect of it, as a fair up and down pull, is so much better than trusting to the clew-lines if brought to the yard to bring it down. It is recommended to take the clew-lines to the cap.

Care should be taken not to make the gaskets fast to the yard; they should be attached to the chafing-spar, and clear of all working parts.

In hoisting a whole topsail for the first time, see that the wooden tub of the parrall is not stuck by varnish to the mast, as, if so, it becomes liable to cant up and jamb. A hand should be aloft to see that the parrall starts fair at the first pull on the haulyards, and to assist it if it hangs. It is a very good plan to rack the two parts of the tie together, just above the roller on the centre ironwork, when hoisting a whole topsail. It then hoists as an ordinary topsail.

The sails should always be close-reefed on the yards before proceeding to sea. Attention to this is considered to be very important.

In unrolling or shaking out reefs with the ship's head to the wind, the bonnet binding against the mast may hang a little, and

Plate 4

Fig. 1.

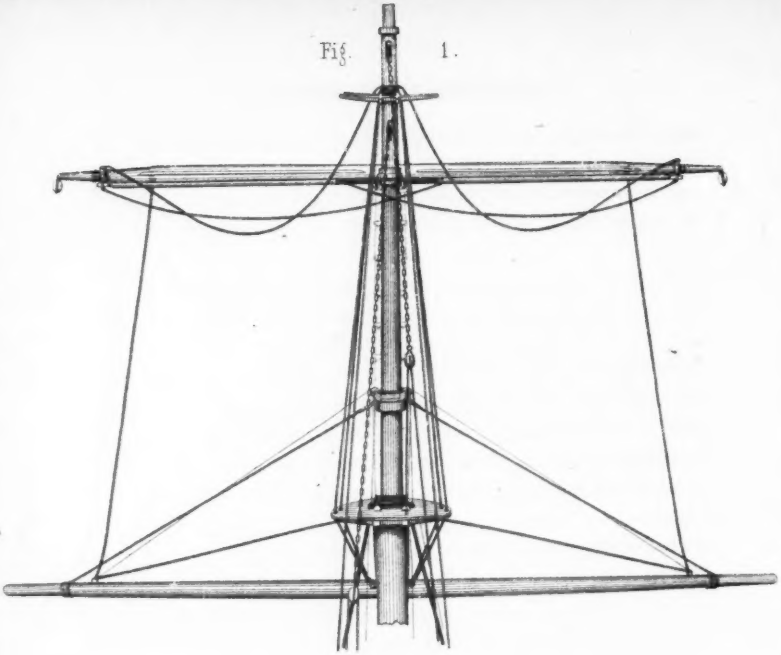
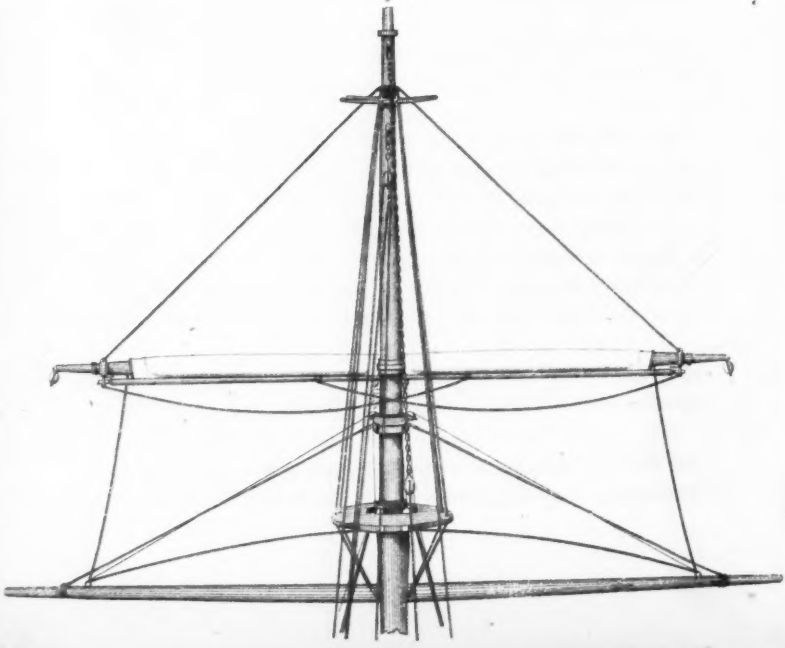


Fig 3.



the centre-roping not render down through the upper fair leader on the bonnet smartly. Violence should not be used; when this is seen, it is better to send a hand aloft to light the bonnet up; and if the sail be slack, the reefing-haulyards should be pulled on to tighten it. The cause of this is generally from slacking too much on the reefing-haulyard in unrolling the sail when aback. Care must therefore be taken to keep the sail taut-set, and not to slack too much on the reefing-haulyard.

The battens on the yard are for the purpose of increasing the size of it at that part where the sailcloth only rolls up, so as to make the sail set fair along the yard. It is, however, impossible to know exactly how a sail will set until it is tried, as, in the event of its having much belly in it or contrariwise, it will require deeper or less battens. The set of the sail, therefore, can always be regulated by the depth or number of the battens. It sometimes, too, may be found necessary to take up more at the leach. When this is the case, it is a good plan to put a woolding of rope round the yardarm, outside the inner turns of the head-earing.

When a ship has been laying up, the iron-work should be looked to, and all rust carefully cleaned off. It should also be well oiled just before proceeding to sea. It is recommended, as a routine, to oil the iron-work every Saturday at sea.

Grease should never be used on the centre covered roping, up and down which the bonnet works. Soap is recommended.

It is considered that the covering of the roping in the centre will last a long time, but of course it will in time wear out. Therefore after a voyage, or when the sails have been much in use, this part should be looked to. The raised edging formed by the covered rope must be as smooth as possible, so as to allow the travellers in the bonnet to work up and down without impediment. The greatest care should accordingly be taken, in repairing it, to have close neat seams, or very snug darns. This is very important.

In loosing a whole topsail, care should be taken to throw off the swinging-iron to which the upper part of the bonnet connects, and kick the bunt well out.

Care must be taken not to fit the buntline-lizard so as to get into the chain when the yard revolves.

Care must be taken not to let the heels of the studding-sail booms get down between the yard and the chafing-spar, as such may jamb the yard in reefing. It is a good plan to have saddles or quarter-irons on the chafing-spar for the studding-sail booms in large ships.

It is recommended, on all occasions of carrying a press of sail, that the paul on the yard be put in, as, by so doing, if the chain-tie, &c., should carry away, the yard is secured. It must be borne in mind that the sail cannot be unrolled with the paul in. A hand must therefore be sent aloft to throw the paul back in unreefing.

Much of the satisfactory working of the patent depends on the chain-tie properly fitting the whelps in the boss. It is therefore recommended that particular attention be given to this on first fitting.

Captain FISHBOURNE.—May I ask you, Mr. Cunningham, whether your sails are furled in the usual way?

Mr. CUNNINGHAM.—Yes.

Captain FISHBOURNE.—Then you will always want sailors for that purpose. This is the first time I have seen the invention, and, as far as appears to me, I think it will answer admirably. Of course one cannot speak precisely at first sight as to what may be the exact result of a new proposal. I should say certainly that the sail would stand better. We know very well that many accidents occur, and that many sails are torn, from the improper use of the reef-tackles, and we know also very well that there is great difficulty in getting an equal strain on all the points both reef and taut. I still say, without the ability to furl, you have not overcome more than half your difficulty on the yard. No doubt you have effected a very great result, but I do not think it is so important as you imagine until you have arrived at that. There is no doubt that you have gained an immense point, but there are circumstances, and most dangerous circumstances, under which vessels are placed when they have got to make sail, or to get in sail altogether. The difficulty that a man-of-war would incur in action would be having to make

sail, or to shorten sail altogether. In the same way in a steamer, from a change of wind or various circumstances, such as springing on a lee-shore with the wind blowing hard, the difficulty is to furl the sail, and you would experience the same difficulty in furling your sail altogether?

Captain NOLLOTH.—It is not often that a vessel wants to take in sail altogether, but every day a vessel wants to reef sail. How often it happens that a merchant vessel shortens sail in the evening, being weak-handed, for fear a squall should come on in the night: with this invention vessels can carry a press of sail at night, knowing that at the moment a squall takes place they can shorten sail; reefing is a daily operation, furling is not.

Mr. CUNNINGHAM.—I can roll my sail up within about a foot of the bottom. I do not undertake the furling; my point is the reefing. By slacking your sheets home you can roll the sails up. Generally speaking, ships are fitted with sufficient rope to get a good balance reef in their topsails, so that there is very little of the sail left but they can carry.

Captain FISHBOURNE.—In steamers it is of immense importance at times to get rid of it altogether; there are circumstances under which they cannot furl the sail, therefore if you could arrive at that it would be an immense thing. I do not in the least question the general utility of the invention to merchant vessels.

Captain A. RYDER.—Mr. Cunningham, how do you shift the sail to bend a new sail—have you to sway it up?

Mr. CUNNINGHAM.—No; it is merely by letting go one pair of haul-yards and hauling upon the other, and then you can reeve the sail.

Captain NOLLOTH.—With a little more drift, or by some mode of fleeting, could you not *nearly* furl as well as reef?

Mr. CUNNINGHAM.—It would alter the whole shape of the mast; I could do it in small vessels, but I found that there would be such a length of topmast. You must increase the step of the topmast; there would be some practical difficulties also, because it would involve an alteration of the shape of the mast. By slacking the sheets, lifting the sheets with clew-lines, you could roll the sail up to a mere nothing. Ships are now fitting with deep top-gallant-sails, so as to include the top-gallant-sail and royal in one pair of sails.

The propelling power of the top-gallant-sail and royal in merchant ships is of great importance; the royal yard and royal rigging is a great deal, merely for the royal. Then by carrying a buntline right down, the sail can be rolled up to a mere nothing at all.

Captain JAMES STOPFORD.—Has your sail ever been fitted in an English man-of-war? if not, what objection can be made to it?

Mr. CUNNINGHAM.—It is now fitting to the "Perseverance" transport at Portsmouth; she is the first.

Captain A. RYDER.—If the topsail-yard happens to be carried away, how do you shift it?

Mr. CUNNINGHAM.—I will read you a portion of a letter which I received a few days ago with respect to a merchant ship called the "Glory," 4 to 500 tons. "I carried away my maintopsail-yard the other day, and in four hours I had the new yard up, the gear fitted, and the sail set."

CHAIRMAN.—How many years is it since you considered that you had brought your plan to perfection?

Mr. CUNNINGHAM.—About five years. There was a great deal to be considered. It was very difficult to arrive at the probable strain of the materials. The gear on a ship's yard is subject to such tugs and hauls that it is almost impossible to calculate what strain the things will have to bear. During the last five years I think it has been perfect. Sometimes vessels will break the ironwork; and there is a curious case which has come to my knowledge. A large ship was dismasted in a typhoon in the China seas; she had her three topsails fitted with my gear, and the Captain saved enough out of two topsail-yards to make one new set of gear, and he came home with his main-topsail-yard fitted. Now he is having his other topsail-yards fitted. I mention that to show that he could adapt the parts sufficiently to get a working yard.

Captain A. RYDER.—I think you may anticipate that there will be still some difficulty in getting your invention introduced into the Royal Navy, excepting transports, and ships of the nature of transports, such as troop-ships, because I think you will find that there will be a great desire on the part of naval officers to retain as much as possible all the exercise aloft which they have hitherto found so useful in developing the sailor's peculiar character, the *esprit*, the

dash, for which we always look and hope to find. I therefore think that you will meet, as I dare say you have, with difficulty in getting your invention introduced in men-of-war.

Captain NOLLOTH.—Good sailors will be wanted as long as the wind lasts, and reefing is good seamanship practice; but we shall not stick to inferior plans for the sake of exercise; if we did, our enemies would not; and, therefore, I suppose this method will be eventually adopted, or not, according to the gradual experience gained of its special (*i.e.* reefing) merits.

Mr. CUNNINGHAM.—There are three French men-of-war fitted with my sails—one, the Arcole; and there are upwards of 3,000 merchant ships fitted with them.

Lecture.

Friday, March 12th, 1858.

Colonel the Hon. JAMES LINDSAY in the Chair.

THE STRATEGICAL AND NATIONAL IMPORTANCE OF EXTENDING RAILWAY COMMUNICATION THROUGHOUT THE BRITISH COLONIES, MORE ESPECIALLY THROUGHOUT INDIA.

By LIEUT.-COL. J. P. KENNEDY, formerly an Officer of the Royal Engineers, Military Secretary to the late General Sir Charles Napier when Commander-in-Chief in India, and Consulting Engineer to the Supreme Government in India for the Railway Department.

WARLIKE preparations are generally the fore-shadowing of devastation, waste, and suffering in the countries to which they refer. The subject we have now to consider is a rare exception to this rule ; it will therefore be gratifying to feel that the measure best calculated to multiply the vigour and effect of British arms throughout the world, is precisely that which can best promote the peaceful requirements and industrial prosperity of those numerous countries covered by the British flag.

Military preparations are generally most costly and unproductive to the country making them, as well as destructive to the people against whom they are made. The military preparations now to be discussed are calculated, on the contrary, to augment the capital and resources of all the parties interested, whilst, by the rapid and overwhelming power of action they confer upon Government, they are likewise calculated to avert those conflicts that are so frequently provoked by the seeming weakness of governments, or by the absence of what is requisite to meet every contingency that may arise.

No country is safe that cannot maintain its policy, whatever that policy may be.

The policy of the British nation has a right to be maintained, because it is based upon individual freedom and opposed to despotism and slavery.

The wide extent of the British empire, and its heterogeneous composition, however, expose it to a vast number of vicissitudes, requiring the utmost amount of forethought and preparation, not only as affecting the progress of every integral part in the arts of industry, but likewise as to the power of maintaining permanent peace, by rapidly presenting, where necessary, any requisite amount of military force. Otherwise, constituted as the world is, there can be no permanent or stable government, and ambitious foreign neighbours or intriguing internal traitors might succeed in subverting the best political structure, and in making wasteful anarchy take the place of peaceful industry in large associations of mankind.

Analysis of British Colonies.

The close accordance between the commercial and military requirements of the British colonies, as regards the subject under discussion, demands a somewhat comprehensive analysis.

First. To estimate the general position of the British empire, home and colonial.

Second. To show how that position can be best secured and advanced for the future—more especially in the East, where it is most endangered, and to which all eyes are now turned with such overwhelming interest.

We are too much in the habit of restricting our measures and aspirations to the dwarfish limits of our native shores, forgetful of the sacred responsibilities heaped upon us by those vast territories and populous nations under British rule in every region of the world; whilst some there are who go the length of asserting that we can derive no greater advantages from our colonial settlements than we should if those settlements were separate and independent states. This, in the first place, cannot be the fact; and, in the second, if it were so, it could not remove the obligation to administer

properly their affairs, so long as they remain dependencies of the British Crown.

There can be no doubt that the continuance of the present high position of the United Kingdom, as well as the power of raising that position incomparably higher, depends upon her colonial possessions, and the plans she may choose to adopt for their future moral, intellectual, and industrial development, as well as for their military organisation and defence.

This subject involves a comparison of the relative and absolute value of foreign countries to the United Kingdom, as contributors to our wants, and consumers of our manufactures and home produce, and of the opportunities we possess to extend the powers of such contributors and consumers as regards their dealings with us.

With this object I have prepared tables which give a general view of all countries in commercial intercourse with the United Kingdom.* Our Colonial possessions are grouped in reference to their locality, making five separate groups, or distinct British Colonial Empires.† Each colonial group and foreign state takes its precedence or standing on the list in reference to the value of British produce consumed or imported in the year 1855, as derived from the returns of the Board of Trade. Thus, the first country in the schedule, or the most valuable customer of the United Kingdom, is the United States of America; the second is the Anglo-Indian Empire; third, the Hanse Towns; fourth, the Turkish dominions; fifth, the Anglo-Australian Empire; sixth, France and her Colonies; seventh, Holland; eighth, the Anglo-American Empire; twelfth, British Mediterranean possessions; eighteenth, Anglo-African Empire; and this classification extends to No. 47.

There are several reasons for giving a view of our colonies reduced to the five groups as shown in the table, rather than considering them as fifty-three unconnected British colonies. Their mercantile capabilities, in reference to each other, can thus be better kept in view, as well as their relative mercantile comparison, and *mutually defensive powers in regard to foreign States with which we may be either on a friendly or a hostile footing.* A single West Indian Island cannot be

* See Appendix No. II. page 88.

† See Appendix No. I. page 87.

compared with any of the powerful Republics of America, either in an amicable or antagonistic point of view; but the united effort of our Anglo-American empire, comprising the Canadas, West Indian Islands, British Guiana, &c. &c. takes, in the aggregate, an important position as compared with the most powerful State, whether the comparison be friendly or otherwise.

It appears that in 1855 the value of our total exports was £95,688,085; in 1856 they increased to £115,826,948; in 1857 to £122,155,237; and of which the ratios of consumption by foreign states compared to British colonies were:

In 1855 as 2·63 to 1
In 1856 ,, 2·47 to 1
In 1857 ,, 2·26 to 1

Thus, in only three successive years, the proportion of British produce consumed by our own colonies has regularly increased from being little more than one-third to very nearly half of the annual amount consumed by all other foreign States throughout the world. The continuance of such a progress as this indicates in our colonies, must, in a very few years, render our commerce and industry quite independent of those shocks which may be directed against them by the wars, ambition, or jealousies of hostile governments. Nor is it to be forgotten in the above comparison, or in conducting our colonial policy for the future, that our largest customer is a foreign State which had been a British colony, and had revolted from us owing to the mismanagement of its affairs.

It appears that the aggregate area of the British home and colonial possessions is nearly 9½ millions of square miles, or 2½ times the area of Europe, with nearly as large a population.

That after deducting about 1½ million of square miles, being that portion of the Hudson's Bay territory north of 60° of latitude, and which it is safer to assume as unfit for settlement, there would remain nearly 8 millions of square miles of a productive quality, or fit for human settlement.

That the gross population of the home and colonial empires exceeds 206 millions of souls.

That, after deducting nearly 28 millions as the population of the

home empire, there remain 178 millions as the aggregate population of the five great colonial empires.

That the relative density of population in those six great empires, home and colonial, is as follows: viz.—

England, taken separately, 334· souls per square mile.
The home empire, in the aggregate, 226· souls per square mile.
East Indian empire, 124· souls per square mile.
Australian Empire, ·2 souls per square mile, or about 5 square miles per soul.
American empire, 1·3 souls per square mile.
Mediterranean empire, 335· per square mile.
African empire, 3·3 souls per square mile.

General average of home and colonial empires, about 26 souls per square mile of productive land, or land fit for settlement.

That Her Majesty's 206 millions of subjects, being about one-fifth of the human race, are made up of 53 different nations, under 53 distinct governments, of which 36, ruling over 34 millions of souls, have constitutional representative institutions, with local elected Parliaments; and 17, comprising 172 millions of souls, are without any representative control of their own affairs, but under the absolute rule of specially constituted administrative agencies appointed by the British Government.

That of the 17 British colonial possessions in question, containing about 172 millions of souls, 16 comprise on the aggregate less than 1 million of souls, whilst one comprises over 171 millions; and *that one*, with its 171 millions, comprising five-sixths of Her Majesty's subjects, who have no voice in managing their own affairs, is in a state of painful disorganisation, owing to the mutiny of a large portion of its native army.

That British produce to the value of over 95 millions of pounds sterling was exported from the United Kingdom in the year 1855, of which 69 millions' worth went to foreign independent states, and over 26 millions' worth, or nearly one-fourth of the whole, went to the British colonies.

That our largest customer was the United States of America, a revolted British colony, which took 17 millions' worth, being at the rate of about 13*s.* per head of her population. Our second customer

was the British Indian empire, which took over 11 millions' worth, being 1*s.* 4*d.* per head of her population. And had her productive energies been fostered as those of the United States have been, so as to admit of a proportional interchange of produce in reference to population, India in that case would have been our customer for 113 millions' worth, or 17 millions more than our entire exports in 1855, instead of merely taking 11 millions worth of goods. Our fifth customer, in the order of produce consumed, was the British Australian empire, which took 6 millions' worth, exceeding the enormous rate of £8 12*s.* 8*d.* per head of her population. Our eighth customer was the British American empire, for nearly 5 millions, or £1 8*s.* 3*d.* per head of her population. Our twelfth customer was the British Mediterranean empire, to the extent of over a million and a half, or £4 5*s.* 8*d.* per head of her population. Our eighteenth customer was the British African empire, for over 1 million's worth, or £1 1*s.* 2*d.* per head of her population.

That the consumption of British produce per head of population in the British Indian empire is 16*d.*, or only

$\frac{1}{24}$	of rate per head of	our American	empire.
$\frac{1}{81}$	,,	,,	African empire.
$\frac{1}{64}$	,,	,,	Mediterranean empire.
$\frac{1}{128}$	,,	,,	Australian empire.

The average wages of an Indian day-labourer is about 3*d.* or one-third of the Mediterranean rate, one-eighth of the English rate, one-seventeenth of the American rate, and one fortieth of the Australian rate.

Progress of British Commerce.

The Trade Returns rendered to Parliament, showing the *official* values of the imports and exports of the United Kingdom for a series of years, will offer the best scale for measuring the progress of our commercial development, and for tracing its sources.

The official values give the real fluctuation of the trade on a comparison of different years, because the quantities of every class of goods imported or exported are respectively represented by an unchanging scale of value, instituted at the establishment of the office of Inspector-general of imports and exports in the year 1696.

We cannot, however, trace in the Parliamentary papers the official returns of the imports and exports further back than the year 1800. The results, even to that extent, are most interesting and satisfactory. Without encumbering our present subject with the entire return, it will suffice to show the progress at intervals of ten years, by taking the yearly average of each decade, commencing with 1800, *showing also the contemporaneous progress in railway construction, viz.:—*

DATE.	Yearly Average. Official Value.		Declared or Real Value. Average of 1854 and 1855.		Miles of Railway in Operation.	Official Value, Increase.		
	Imports.	Exports.	Imports.	Exports.		Imports.	Exports.	Aggregate.
1800 to 1810	21,273,938	36,445,227	„	„	„	„	„	
1810 „ 1820	34,342,952	50,385,385	„	„	„	13,069,014	13,940,158	Exports: 46,463,995
1820 „ 1830	37,641,966	54,430,966	„	„	32	3,301,954	4,045,581	Imports: 28,925,080
1830 „ 1840	50,199,018	82,909,222	„	„	1,500	12,554,112	28,478,256	
1840 „ 1850	76,522,179	137,575,917	„	„	6,621	26,323,161	54,666,695	Exports: 135,409,871
1850 „ 1855	114,020,896	218,319,693	148,125,924	116,267,372	8,307	37,498,717	80,743,176	Imports: 63,821,878

Those results show an average annual increase of official value in the second decennial period over the first amounting to about 13 millions in imports, and 14 millions in exports. Of the third over the second, amounting to above 3 millions imports, and 4 millions exports. Of the fourth over the third, 12½ millions imports, and 28½ millions exports. Of the fifth over the fourth, 26 millions imports, 54 millions exports. Of the sixth, being only half a decennial period over the 5th, of 37 millions imports, and 80 millions exports.

Stranger still, the increase during the first four decennial periods, or an aggregate of *forty years*, from 1800 up to the establishment of railways, was, for imports, but 29 millions, and exports 46½ millions; whilst the increase during the last two periods, embracing an aggregate of *only fifteen years, during which the effect of railways at home has been fully developed*, was for imports nearly 64 millions, and for exports over 135 millions. Thus, taking the combined elements of time, and quantity of produce interchanged,

the annual increase in the latter period would be as about 13 compared to about 2 in the former.

Sources of Increased Production.

This is assuredly a most triumphant comparison as regards the British producer, and gives him the most substantial security he can have for a continuing and increasing prosperity.

It can be easily and rationally accounted for by two most gratifying and healthy causes.

First. The removal of physical obstructions to our industry; in which may be included those agents that aid human labour in creating, or manufacturing, our produce, and those that facilitate its transport from place to place, viz.—

1st. The progressive improvement in machinery generally.

2nd. The application of steam as a motive power to machinery.

3rd. The improvement and extension of ordinary carriage-roads and canals.

4th. The introduction and progressive improvements in steam-boat transport.

5th, and finally. The introduction of the railway system, with its rapid co-operator, the electric telegraph.

Secondly. The removal of British imposts antagonistic to our production and commerce.

In considering the question of physical impediments to commerce in our foreign possessions, we find that our colonial empires, to be put upon a footing with the United States of America, should, within certain respective periods of time, be ultimately furnished with additional railway intercourse to the following extent: viz.—

Our Anglo-Indian empire	12,423 miles
Anglo-Australian empire	31,857 „
Anglo-American empire	23,640 „
Anglo-African empire	1,494 „
Total for the British Colonies . .	69,414 „

This estimate of required railways for the colonies, based upon the United States existing rate of 1 mile to 112 square miles of area, is certainly a low one. It is only one-eighth of the proportion in operation in the United Kingdom. The American scale would give

an average by which, supposing the railways uniformly laid down, the most distant points would be 66 miles from any railway.

The scale of the United Kingdom is 1 mile of railway to about 13½ square miles, and would make the most distant points average about 6¾ miles from any railway.

The scale of England taken separately would give about 9 square miles per mile of railway, making the greatest distance of any point from a railway, if uniformly projected, 4½ miles.

The scale of the most active manufacturing counties in England, as Lancashire, Warwickshire, and Staffordshire, would give under 5 square miles of territory per mile of railway, making the greatest distance of any point from a railway less than 2½ miles.

Territorial extent, however, is only one of the elements of consideration in dealing with the question of railway accommodation, and assuredly the American scale of 112 square miles per lineal mile of road, is the lowest that should be applied to any *inhabited* country even where the general industry is limited to agriculture.

The second element in importance is the density of the population, and this element should regulate the comparative or relative progress of construction, to be effected in different places respectively.

The scale of 112 square miles of territory per mile of railway we find operating in the United States, where the population, chiefly agricultural, averages 9 to the square mile, and the rate of progress by which 26,000 miles now existing were accomplished there, has averaged from the commencement of their construction in 1830 about 1,000 miles a year; whilst in several years they opened upwards of 2,000 miles per annum, and in one particular year they opened close upon 4,000 miles.

It is clear that, in estimating the requirements of our differently circumstanced colonial empires, the peculiarities of each must be kept strictly in view. Our Indian empire averages 124 souls per square mile; our Australian empire, ·2 per square mile, or 5 square miles per soul; our American empire, 1·3 per square mile; and our African empire, 3·3 per square mile.

Hence it appears, that, as every part of our Indian empire is already occupied with a population nearly fourteen times as dense as that of the United States of America, and as they have no voice

in the conduct of their own affairs, our efforts ought to be proportionally stimulated to supply their indispensable industrial requirements. We have, in fact, fourteen times the necessity in India that the Americans had in their country to furnish equal amounts of surface with those conveniences that shall open up markets for the industry of the inhabitants.

The circumstances of our other great colonial empires are widely different; in the first place we have, with few exceptions, removed all responsibility from England to themselves respectively, by giving them the full legislative control over their own territories and finances. Secondly, in such as are but partially inhabited, it is only requisite to intersect their extensive territories by lines of intercourse gradually, and as the population extends itself.

The case, then, stands thus as regards the railway requirements of our colonies. An aggregate amount of 69,414 miles of railway, or about 9,000 miles more than all that have been hitherto constructed throughout the world, would furnish the colonial empires of Great Britain with a similar proportion of railway intercourse in reference to area, as that already existing in the United States of America, being 1 lineal mile of rail to every 112 square miles of territory. Of this gross amount 12,423 miles is the proportion due to our Indian empire, already occupied by a dense population of 124 souls to the square mile, whose industry (by the absence of any general means of intercourse) and whose interests, as well as the interests of the mother country, call for the supply of at least that amount of railway with the utmost rapidity that its execution will admit of, and which the United States have already proved might be accomplished in a term of six and a half years, at the rate of 2,000 miles a year.

With regard to the balance of 56,991 miles which may ultimately be required in the remaining colonial empires of Great Britain, as ninety years may elapse before their average population shall reach nine souls per square mile, a corresponding gradual construction of about 600 miles per annum, distributed amongst them where most wanted, would probably keep pace with their requirements, and relieve our future emigrants from those horrors and hardships which their predecessors were forced to encounter in times past. It must,

however, never be forgotten that if the wants of the principal Australian, American, and African colonies are not duly supplied, their inhabitants have themselves alone to blame, as they have the legislative control of their own affairs and finances; whereas, if outcrying deficiencies be permitted to continue in India, the British people, who exercise a despotic and unlimited control over the policy and finances of that great continent, must bear the entire scandal, and its ruinous consequences.

So urgent did these considerations appear to me, both as regarded the industrial progress and the military protection and defence of India, that on my return from that country in 1852, after having held the appointment of Militaty Secretary to the Commander-in-Chief, as well as that of Consulting Engineer to the Supreme Government in the Railway Department, I felt bound to address a report* on the subject of railways to the Home Government of India, from which the following are extracts:—

Military Occupation of India.

"No one will deny that the efficiency of an army is in some inverse ratio to the time required to concentrate such a preponderating force of well-trained troops on any given point of its lines of defence, as shall secure victory over the largest hostile force that can be expected to attack it."

"When the movements are slow, as must be the case when the troops have to concentrate by marching, each limited district must be copiously armed for its own defence and protection; but when the power of concentration is rapid, as in the case when troops can be brought together to any given point by railway from very distant stations, then a comparatively small force will suffice for each particular district."

"What the exact ratio of increased efficiency may be as compared with the increased power and rapidity of concentrating troops, and conveying artillery and commissariat supplies to the first place of assembly for a campaign, as well as in the subsequent supply of reinforcements and provisions, it is difficult to express in precise numbers. But it would probably not be straining the argument to

* 14th Sept. 1852.

assume that two-thirds of any given army for the protection of British India would be much more efficient, where a field force of 50,000 or 60,000 men, with ample artillery, stores, and provisions, could be congregated on any point of its vast lines of defence in twenty, forty, or sixty hours, than the whole of such an army would be, under the present system, requiring a mean period of three or four months to bring such a force together."

"It is not for a moment implied that, in the subsequent manœuvres of a campaign, the general can be aided by the existence of railways. Their advantages, in a military point, are only assumed to apply to the first concentration of a force, and to its after-reinforcement with troops, provisions, and stores. But all those acquainted with the Indian climate and practices, will understand how much greater those advantages would be as applied to India than if our consideration had reference to Europe. In India, marching or campaigning in summer is out of the question, unless at a fearful expense of life and health to our troops, whilst, from the vast extent of territory we occupy there, the ordinary dispersion of our forces may be nearly in the ratio of one thousand miles as compared with one hundred at home."

In the report referred to, it was shown that a proper system of railways (whilst increasing the efficiency of the army) would enable a reduction to be made in the military establishments of India equal to £2,332,482 per annum, representing a capital of £58,312,050, if raised at 4 per cent.; and which capital, if invested in railways at an average cost of £6,000 per mile, would furnish 9,718 miles of way.

The report was sent by Government to India, and circulated to the authorities there. It was likewise laid before Parliament. Had the principles therein urged been adopted with the energy exemplified in the United States of America, 2,000 miles of railway per annum might have been opened during the last three years in India, which would have placed us in a condition to deal effectually with the mutiny of the Bengal army, if it had not altogether prevented the occurrence of that mutiny.

The mutiny has, however, rendered manifold more necessary the adoption of that energy which has unfortunately been so long delayed.

To ascertain the strategic effects of extending railways in India, we must estimate and compare the amount of troops that would suffice for the safe occupation of that country, both *with* and *without* railways.

At the breaking out of the mutinies in 1857, we find by returns offered to Parliament on 4th December, 1857, that the force of the British Government in India was 246,872 men of all arms; of which 42,500 were Europeans, and 204,372 natives, distributed amongst 34 military "divisions" at 228 stations. These proportions give a ratio of native troops to European troops as nearly 5 to 1.

By another return made to the House of Commons on the 15th April, 1852, we find it stated that

The Queen's and Company's European troops amounted to	49,408 men
The Company's native troops, including contingents .	276,432
Making a total number of	325,840

and giving a ratio of above $5\frac{1}{2}$ natives to 1 European. The same return states the military resources of native princes at 398,918 men, making the gross ratio of Company's and native princes' native troops to European troops $13\frac{1}{2}$ to 1. It likewise states the

European artillery at	7,436 men
Company's native artillery	9,004
Native princes' native artillery	12,962
Total	7,436 to 21,966

making the ratio of Company's native artillery to European artillery 1·2 to 1, and Company's and native princes' native artillery together, compared to European artillery, 3 to 1. It states

The Company and Queen's European cavalry at . .	4,133 men
The Company's native cavalry, including contingents .	39,758
Native princes' native cavalry	68,303
Total	4,133 to 108,061

making the ratio of Company's native cavalry to European cavalry over 9·6 to 1, and gross ratio of Company's and native princes' native cavalry to European cavalry over 26 to 1.

It does not appear in either the return of the 4th December, 1857, giving the strength of the Queen's and Company's forces at

the outbreak of the mutiny—nor in the return of 15th April, 1852—that all the local corps, forming a very considerable number of native troops in the aggregate, are inserted.

As regards the number of troops, it will be safer to base our calculations on the more detailed return of the 15th April, 1852, making the gross number, including contingents, 325,840 men of all arms.*

As regards their cost, we shall be guided by the average of 4 years, as laid before Parliament in the East India Territorial Revenues and Disbursements Return for 1855–6. This average makes the annual military charges, not including buildings, £10,106,679.†

Referring to minute No. 2 of the late Governor-General, dated 5th February, 1856, and presented to the House of Commons on the 10th December, 1857, his Lordship, in estimating the proper number of European troops for India, quotes at para. I. the opinion given by Lord Wellesley fifty years before, as follows:—"Great errors would arise from fixing the European military establishment by any given proportion which may be supposed to exist generally between our European and native establishments. It would be impracticable under the real state of the case to devise any accurate principle by which such general proportion between our European and native troops should be regulated."

Had such dearly purchased experience as that of the last year been possessed by Lord Wellesley when the opinion quoted was written, he must have arrived at a very different conclusion. He would in that case have asserted that the very first principle to be laid down in regulating the establishment of an Indian army of occupation must be, *a safe proportion between the number of European and the number of native troops that should be maintained.* The fact must be, that the probability of any large section of our native army revolting and turning their arms against our European troops never can have entered into his calculation, or he must have fixed such a safe proportion between their respective numbers as would have rendered such an act either impossible or comparatively innocuous.

* See App. 3, page 90. † See App. 5, page 93.

With our present experience we may assume that henceforth the number of native troops in the Indian army *shall not be allowed to exceed that of the Europeans*, but that they may be safely employed in equal numbers. The artillery, engineers, and sappers, however, to be exclusively Europeans!

Even under this arrangement, the force, although *secure*, would not be so effective, for occupation purposes, as the larger proportion of natives made it, because natives are much more capable than Europeans of executing those numerous duties requiring exposure to climate at all seasons of the year.

We must now proceed to consider, in detail, the effect that a proper system of railway intercourse would have upon the operations and strength of the army, by enabling troops rapidly to penetrate every district; and limiting, for the present, the estimated amount of such intercourse to the American scale of 1 lineal mile of railway to every 112 square miles of country—a proportion that (supposing a uniform distribution) would give an average by which the most distant points of the country would be only 66 miles from the nearest railway. This would be but six ordinary, or three forced marches from the railway or general base of all military operations in India—a base of extraordinary strength, from the rapidity with which every point of it can be furnished with the required amount of troops, provisions, and stores.

About 12,000 miles of railway would suffice on this scale, 6,000 miles being main lines, along which the army are assumed to be distributed at equal intervals in brigades. The length of those intervals, therefore, would depend upon the aggregate strength of the army.

The remaining 6,000 miles would be second-class lines, branching from the main lines to multiply the communication throughout the local districts.

We shall now compare the power of concentrating troops; that is to say, of effecting the most essential requirement of war, by presenting the greatest mass of forces, efficiently supplied with provisions and military stores, upon the most decisive point or points of our Indian territories, in the shortest time and at the smallest cost—*with* and *without* railways.

Assuming that in either case the army of occupation should be posted in brigades of one European regiment, one native regiment, one squadron of European cavalry, one squadron of native cavalry, and a European field battery of four guns and two howitzers, placed at equal intervals along the main line of 6,000 miles. Some modification of which principle may be taken as the proper distribution for an army of occupation under all circumstances; when nearly every district must be regarded as in need of military precautions on the part of its British rulers.

The table at Appendix 4* shows that it would require 48 days to concentrate, *by marching*, a force of 53,000 men from an aggregate army of 325,840, costing annually £13,776,363; whereas an equal number could be concentrated by railway in seven days from an aggregate army of only 100,000 men, costing only £6,202,045; that is to say, the same number of 53,000 men could be brought to any one given point *by railway* in about one-seventh of the time, from an army under one-third of the strength, and costing under half of the amount, as compared with the assembly of a similar force at the same point from the larger army without railways! To assemble, *by marching*, 53,000 men from an equally distributed army of 100,000 men, would occupy nearly half-a-year instead of seven days by rail!

The *advantages of railway transport for troops* in India over marching are, in fact, in the following compound ratios, viz.:—

As regards time in concentrating a field force, as 24 to 1.

As regards the economy of military establishments, over 2 to 1.

As regards *the power* of reducing the total numerical force of the army, over 3 to 1.

As regards the power of reducing the number of Europeans, 3 to 1.

As regards the protection of Europeans from fatal climate exposure, beyond calculation.

As regards the rapid and successful issue of every war or conflict, beyond calculation.

As regards the averting of those contingencies that produce war and disturbance, beyond calculation.

* Page 91.

Equally striking results would attend the establishment of railways as regards every other department of the government, above all would they appear in the development of industry, trade, and commerce.

It is clear that *without railways* our army in India cannot safely be reduced below its former numerical establishment of about 325,000 men, and that of this gross number half, or 162,500, must be Europeans, the whole costing £13,776,363; whilst *with* railways the gross force may be reduced to 100,000 men, the Europeans to 50,000 men, and the military charges to £6,202,045; and that this enormous reduction in men and money would be attended with a sevenfold rapidity in bringing together a field force of 50,000 men at any point, as compared with the power that the larger army would confer without railways. The reduction allows, too, for the artillery and engineer corps being maintained on their former full numerical strength, converting what was previously composed of native soldiers in these arms into an equal number of Europeans. And it is clear, whilst on this subject, that railways will admit of an improvement in the calibre of our field artillery, whilst they will facilitate incalculably that difficult process of bringing up siege trains when required at any remote point. We shall never *then* hear of generals being obliged to delay for weeks, or months, the operations of a campaign, until a few heavy guns and stores are brought with infinite toil and cost to the front.

This question assuredly deserves the closest attention of every British and Indian statesman. It offers a solution of our principal Indian difficulties, past, present, and future.

Indian Finances.

Even irrespective of the mutiny question, our Indian finances have been in a state of chronic disorder. The parliamentary returns show that for the last four years there has been an average annual deficiency of revenue amounting to £1,676,333.

The increased military expenditure of over 3½ millions consequent upon the mutiny, will thus bring the future annual deficiency of revenue to above five millions sterling; and this state of things must continue until a safe reduction can be made in the military force.

No such reduction can be made until improved and rapid means of moving our troops shall enable diminished numbers of them to act with increased effect.

The judicious construction of 12,000 miles of railway, which can be effected within seven years, without any cost to Government, would admit of a reduction in the military force to the extent of over 7½ millions sterling annually; thus turning an annual deficiency in the revenue considerably over five millions sterling into an annual surplus of more than two millions.

Means of Intercourse and Transport.

Every one conversant with the requirements of industry or of war, admits that a first principle essential to ensure the success of either is the advantage of convenient lines of intercourse, with efficient means of transport adapted to those lines.

Few, however, having the power take the requisite steps, *at the fitting time*, to put their theory into practice.

Sir C. Napier never allowed this principle to sleep. His masterly genius laboured with indefatigable perseverance and prescience to provide beforehand all that could secure the results expected of him, and increase the efficiency, security, and well-being of those entrusted to his charge, under every contingency that might arise.

His incessant attention was invariably given to his means of transport and intercourse. His most hardy exploits were necessarily crowned with victory. His troops were always at the decisive points, at the right times, when least expected, and fully provided.

His intense appreciation of these essentials in war originated his masterly conception of high-bred camel corps, capable of carrying bodies of fighting men eighty miles a day. It is not surprising that he quickly restored the prestige of British arms in India, previously tarnished in Affghanistan.

The Emperor Nicholas would probably have admitted in theory the importance of transport for his troops and stores, but fortunately he did not act upon that theory in practice, and hence his successor was defeated at Sebastopol.

How different would have been his position had he extended the Petersburg and Moscow Railway to the Black Sea before he ordered his army across the Pruth. His forces about Petersburg would, in that case, have formed so many more divisions of the Sebastopol army, and the whole of the Imperial forces could have been available for the defence either of the north or south, as required, in fewer days than would have been wasted in marching 100 miles, avoiding that fatality which was known to attend those scanty reinforcements to which his utmost efforts were limited. Fortunate was it for the allies upon that occasion that no such railway existed!

Base of Military Operations.

By considering railways throughout India as an extended base of military operations, the perilous and difficult contingencies which have hitherto accompanied the assembly of large forces at particular points would be avoided. Those forces have necessarily been drawn, in the first instance, from the stations nearest to the point attacked, leaving the district of country which ought to have been kept strongest without troops.

Such a course never could be required where the facility of railway intercourse existed. The force required could be withdrawn in any fitting ratio from all districts, however distant, or from those that could most safely spare them. Assume the army of India consisting of 80 brigades of 2,500 men each, stationed at 80 distinct points 75 miles apart, and that 100,000 men were required for the field, in one or more places. Such a force could be assembled in a week, by withdrawing alternate brigades, and allowing their posts to be occupied by half-brigades taken from the adjacent districts. Thus one-half of the entire army might be in the field, and one-half of the usual forces would remain for the occupation of every other district, without denuding any.

It is objected by some that railways are not to be depended upon in military operations, because—like all our other appliances—they may be destroyed by an enemy. Experience thus far does not give weight to this objection, although it is natural to assume that this mode of cutting off lines of communication would be at

once resorted to; still the few instances in which it has occurred amongst the many occasions which have given an opportunity for its adoption, rather prove that it is a frivolous criticism. Those instances have occurred in continental disturbances, and have not in any case produced serious damage to a line: a few rails being lifted is supposed to intercept the communication, whereas such slight damage is so easily repaired that it really is not worth consideration; and to remove any considerable length of way becomes an effort of much difficulty, involving the use of skilled labour.

In a military point, however, and in a country like India, this difficulty should be as as much as possible increased by selecting a class of permanent way in which the fastenings of the rails are in the greatest degree protected and concealed. It so happens that the best class of rail we possess is precisely of this description, and under ordinary circumstances it would defy the depredations of unskilled labour.

The facility which a railway affords for its own defence is so great, by enabling a rapid concentration of troops at any point, that if a Government cannot defend it, their functions may at once be assigned to those who can. Defeat can only occur where the inhabitants are in persevering, unanimous, and vigorous hostility with their rulers; and even in that extreme case the railway system gives the most effectual support to any Government, in developing its military power and enabling it to maintain its position.

The most vulnerable points of a line of railway may be considered its bridges. But these likewise should be constructed so as to admit of easy repair. And in important places they may be defended by *têtes de pont*, which would add little to the cost of constructing the line, and would afford beneficial service, both as regards a railway company and the public.

The course I myself adopt is to use iron, both in the piers and superstructure of Indian bridges, cast-iron piles for the piers, and uniform 60-feet spans of wrought-iron for the superstructure. Hence, to provide against damage in such cases, it is only necessary to have a few spare piles and spans at depôts along the line, and, the dimensions and parts being uniform, any evil is remedied at once. There can be no misfit or delay.

Another railway defence, which answers a double purpose, consists in a regular system of side-cuttings for obtaining the requisite embankments of the line, and the use of those formidable growing fences peculiar to India, with short flanks at fixed intervals where sidings occur; by these means strong defences may be obtained without cost, in the entire length of a line of railway. These arrangements, with the power of bringing up to any point of the line by train, in obedience to a telegraph order, the requisite number of troops to meet any danger, would furnish a well-defended, continuous line throughout the length of every railway, and in a country like India would give to the Government, without cost, the most formidable military strength.

It is quite clear from what is now going forward that we must for the present calculate on maintaining a largely increased European force in India, however improved the principle may be which shall regulate our future organisation and enlistment of native corps; but the precise extent of that European force from year to year may be regulated in some inverse ratio to the amount of railway intercourse that shall be brought into operation from year to year.

Our European troops can only be exposed to Indian field-service, without great damage, during six months of every year. Our power of meeting contingencies will depend upon our power of concentrating our European troops; wherever we can assemble 10,000 or 12,000 Europeans, with the requisite cavalry and artillery, we shall probably be victors over any number of natives that may present themselves against us. But what must be our European strength in a territory about 2,000 miles long by 2,000 wide, to admit of concentrating 12,000 British troops in as many points as may be requisite by ten-mile marches, limiting our period for concentrating such a force, and following the concentration up by a decisive campaign, to six months? I believe that 150,000 British soldiers would be barely sufficient under such circumstances for the military occupation of India; and its occupation by European troops must always be exposed to the disadvantages of which the natives thoroughly understand the value—namely, that we cannot operate during the long hot period of the year without most disastrous consequences to health. Their mutinies, insurrections, and disturbances are gene-

rally based upon the knowledge of this fact. They commenced the present mutiny at the setting-in of the hot season; they commenced their mutiny in 1850 at the same season. They will always select this season for their tumults, as it must give them an enormous advantage to force Europeans to take the field against them during the summer and monsoon.

The real question, then, of our military occupation of India, under the very peculiar circumstances of our physical constitution, the climate of that country, its vast extent and population, and its military tendencies, is, How can we best concentrate a reasonable force, *where required*, in the shortest time, at the smallest cost, and with the least possible exposure to heat? There can be but one answer—By the immediate and rapid extension of railways. There is no other process which can possibly give a modern European force the substantial control of our Indian empire; and until we shall have completed that process, our regiments must suffer much heavier mortality in marching to the scene of their operations than the most hard-fought conflicts in the field can ever inflict.

Those consequences have at this moment arrived at a most fearful and disastrous climax. Our large native army of Bengal is in a state of mutiny, and we have failed to provide in proper time the indispensable appliances existing in other civilised states, which could alone have enabled us to meet such a peril by rapidly concentrating our few British troops in force at any point required.

We were on the brink of a similar crisis in 1850, but Sir Charles Napier was then our commander-in-chief; and that glorious model for British generals and British colonial-governors rapidly extinguished the extensive symptoms of mutiny as they appeared. There is no doubt that India was then only saved by his intellect and vigour from such horrible scenes as have now been enacted.

The remedy for the future must still be found in the precise measures delayed; but the disasters will have cost a sacrifice of capital which would have amply sufficed to furnish India with those essential railways that would have prevented their occurrence. Had forty or fifty millions sterling been advantageously invested in railways *at the fitting time*, no mutiny of Sepoys could have mate-

rially damaged the state of India, nor would any such enterprise have been attempted. It will now cost a larger amount to put down the mutiny, and remedy the material destruction it has produced, leaving the investment for railways still to be incurred in addition. But how are we to estimate the horrors and human sufferings it has entailed—the loss of life—the injury to our national fame—and to the character of our governing policy in the eyes of all mankind, that the mere possibility of such events having occurred under our rule must convey?

It may be imagined by some that too much stress is laid in this paper upon the construction of railways. The answer is, that railways and roads of intercourse are in themselves of no interest whatever, except as indispensable to the requirements both of peace and war; that in our home empire, where industry is pre-eminently developed above all other countries, we have found it requisite to facilitate intercourse by opening 168,961 miles of communication of all classes, being at the rate of about one lineal mile to seven-tenths of a square mile of area, whilst the aggregate means of intercourse in India would probably not exceed one lineal mile to 500 square miles of territory, and that consequently her inexhaustible iron and coal mines, her vast cotton fields, which would more than meet the entire demands of Manchester, her innumerable varieties of commercial and industrial elements, her vast unemployed population, are all stagnant and unprofitable, owing to this one deficiency. Why should mines be worked? why should cotton or any other commodity be cultivated, if the produce cannot be conveyed to a market? The Indian labourer is accused of indolence. What inducement has he to exertion for the miserable remuneration of 3*d.* a day in a most oppressive climate? How can he reap a higher remuneration when his produce must come into competition with the produce of other countries, the transport of which may cost one-tenth of what his costs? Imagine goods conveyed 400 or 500 miles on bullocks' backs without carts; how can they compete with those which have the advantage of civilised mechanical appliances? And now that war has broken out, how can our limited numbers of British troops meet the emergencies at an

infinite number of points, scattered over a territory 2,000 miles long.

I projected and partly constructed a very extensive line of intercourse in India, across the Himalaya Mountains, of which the object was to supersede an oppressive system of tribute labour, and to enable carts to be introduced for the Hindostan and Thibet traffic, where the transport of goods had been previously effected upon the backs of human beings, and of flocks of sheep and goats, each little animal carrying about eight pounds of grain, in a contrivance like a pair of small saddle-bags.

I cannot refrain from giving in relation to this work a characteristic of the noble and patriotic feelings which invariably influenced Sir C. Napier throughout his life.

He, without hesitation, consented to my taking the gratuitous direction (at such intervals as my military duties permitted) of this important work for the Government. Further still, he stimulated every officer on his staff to give in like manner their valuable assistance. Thus were Colonel M'Murdo, his Deputy Adjutant-General, Colonels William Napier and Hardinge, his aides-de-camp, and Mr. Freeman, *in their hours of leisure*, late and early to be found conducting the construction of their respective portions of this work. Many would have considered it undignified to see their staff turned into road-makers. Sir C. Napier's noble mind never confounded real dignity with pompous pretension.

Amongst the few efforts made in India to open intercourse, irrespective of railways, the greatest has been the construction of what is termed the Grand Trunk Carriage (not rail) Road from Calcutta to the north-west of India, and this, strange to say, subsequently to the invention of railways. Had the Home Government appreciated what was going on in India they would have understood, in 1830, that a railway, and not an old-fashioned carriage-road, was the fitting requirement as a grand trunk communication between Calcutta and the north-west of India; and a railway in that direction would have been opened, which would have enabled the Government at once to crush any Sepoy mutiny, without exposing their Europeans to long and destructive summer marches.

Proposed Statistical Department.

I have now, in conclusion, to apologise for having so long trespassed on the time and attention of this meeting, and still more for having so imperfectly dealt with the important subject which the managing committee confided to my discussion.

That subject, it will be perceived, involves much statistical analysis, for which the data are exceedingly scanty, and I may therefore be excused in venturing to suggest that no association in the empire appears to be so pre-eminently fitted as the United Service Institution for remedying the deficiency that exists as regards British colonial statistical information.

Looking to the wide dispersion of our Army, British and Indian, and our Navy, whose officers furnish the members of the Institution, there is little doubt that several of our members are to be found in every British colony. It is equally certain that those gentlemen would willingly give their aid in furnishing to this Institution such useful specific information as may now be deficient in reference to the respective localities where they are stationed, and which, if recorded in uniform tables, supplied to them from the Institution and returned with explanatory reports, might be of incalculable value, whether as regards the development of colonial industry and wealth, or that of the military strength of the empire.

It is with this view that I venture to suggest the importance of adding a statistical department to our interesting Institution, with the firm conviction that the results must prove a vast public benefit, alike creditable and gratifying to our Association.

APPENDIX, No. 1.

SCHEDULE of the Home and Colonial Empires of Great Britain, the Colonies being grouped in Five Distinct Colonial Empires, and standing in the order of their Consumption of British Produce in the year 1855, as shown by the Returns of the Board of Trade.

	NAMES OF COUNTRIES.	Area in Square Miles.	POPULATION.				Per Square Mile.	Value of Produce of United Kingdom Consumed or Imported in the year 1855, as by Returns of Board of Trade.	
			Countries having Representative Governments.		Countries not having Representative Governments.			Value of produce consumed or imported.	Per Head of Population.
			No.	Population.	No.	Population.		£	£ s. d.
Home Empire.	England	50,922	1	17,048,449	...	...	334	...	...
	Wales	7,398	1	1,005,721	...	...	136	...	...
	Scotland	31,324	1	2,922,362	...	...	93	...	...
	Ireland	32,518	1	6,552,385	...	...	201	...	...
	Isle of Man	281	1	52,387	...	...	187	...	...
	Channel Islands	113	1	90,739	...	..	803	468,078	5 3 1
	Heligoland	5	...	...	1	2,215	443	500	0 4 6
	Total	122,561	6	27,672,043	1	2,215		468,578	
British East India Empire.	East Indies	1,365,664	...	...	1	171,317,155	125·4	9,949,154	0 1 2
	Singapore	275	...	...	1	57,421	208·8	672,964	11 14 4
	Aden	5	...	...	1	40,000	8000·0	22,313	0 11 1
	Ceylon	24,700	1	1,710,124	...	...	69·2	305,576	0 3 6
	Labuan	30	...	...	1	1,150	38·3	...	...
	Mauritius	708	1	192,503	...	...	271·8	363,173	1 11 5
	Hong Kong	29	...	...	1	55,715	1921·2	389,265	6 19 8
	Total	1,391,411	2	1,902,627	5	171,471,441		11,642,445	0 1 4
British Australia.	Victoria	90.000	1	273,865	...	...	3·04	2,789,776	10 3 8
	New South Wales	500,000	1	251,315	...	...	·5	1,928,735	7 13 5
	South Australia	312.000	1	92,545	...	...	·2	621,788	6 14 4
	Western Australia	45,000	...	...	1	11,976	·2	73,241	6 2 3
	Not Settled	2,500,000	...	...	...	...	...	...	...
	Van Diemen's Land	24,000	1	68,609	...	...	2·8	616,957	8 19 10
	New Zealand	97,000	1	28,683	...	..	·2	248,469	8 13 3
	Total		5		1	11,976		6,278,966	8 12 8

British Australia	Victoria	90,000	1	273,865	...	...	3·04	2,789,776	10 3 8
	New South Wales	500,000	1	251,315	...	...	·5	1,928,735	7 13 5
	South Australia	312,000	1	92,545	...	...	·2	621,788	6 14 4
	Western Australia	45,000	...	...	1	11,976	·2	73,241	6 2 3
	Not Settled	2,500,000	...	...	...	...	...	...	...
	Van Diemen's Land	24,000	1	68,609	...	...	2·8	616,957	8 19 10
	New Zealand	97,000	1	28,683	...	..	·2	248,469	8 13 3
	Total	3,568,000	5	715,017	1	11,976		6,278,966	8 12 8
British American Empire.	Canada	242,482	1	1,842,265	...	...	7·5	1,515,823	0 16 5
	New Brunswick	26,000	1	193,800	...	...	7·5	370,560	1 18 2
	Prince Edward's Island	2,124	1	71,284	...	..	33·4	78,688	1 2 0
	Nova Scotia and Cape Breton	18,717	1	276,117	...	...	1·5	456,145	1 13 0
	Newfoundland and Labrador	35,913	1	96,864	...	...	2·6	381,152	3 18 8
	Hudson's Bay Settlement	3,700,000	...	...	...	...	...	82,963	...
	West Indian Islands	13,753	12	721,578	2	92,723	59·2	1,389,992	1 14 1
	Bermudas	36	1	11,092	...	...	308·1	...	...
	Honduras	3,680	1	4,500	...	...	1·2	168,566	37 9 1
	British Guiana	100,000	1	127,695	...	...	1·2	421,398	3 6 0
	Falkland Islands	5,000	...	...	1	500	·1	1,608	3 4 3
	Total	4,147,715	20	3,345,195	3	93,223		4,866,895	1 8 3
British Mediterranean Possessions.	Crimea	...	...	...	...	...	...	493,398	...
	Gibraltar	3	...	...	1	16,000	5333·3	829,354	51 16 8
	Malta	115	1	131,401	...	...	1142·6	625,823	4 15 3
	Ionian Islands	1,041	1	241,493	...	...	231·9	211,886	0 17 6
	Total	1,159	2	372,894	1	16,000		2,160,461	4 5 8
British African Empire.	Cape of Good Hope	118,256	1	224,827	..	...	1·9	791,313	2 5 9
	Natal	18,000	...	...	1	120,627	6·7	...	
	Gold Coast	6,000	...	...	1	151,346	25·2	111,182	0 14 8
	Sierra Leone	25,000	...	...	1	44,501	1·7	147,271	3 6 2
	Gambia	19	...	...	1	5,693	299·6	47,641	8 7 4
	St. Helena	47	...	...	1	6,263	133·2	31,715	5 1 3
	Ascension	35	...	...	1	400	11·4	6,408	16 0 4
	Total	167,357	1	224,827	6	328,830		1,135,530	2 1 2
	Gross Total	9,398,203	36	34,232,603	17	171,923,685		26,552,875	
	Deduct portion of Hudson's Bay Territory north of 60° as unfit for settlement	1,500,000							
		7,898,203		206,156,288			26·0	26,552,875	

APPENDIX No. II.

TABLE showing the PRECEDENCE of those FOREIGN and COLONIAL STATES which are the most valuable CUSTOMERS of the UNITED KINGDOM; the Colonial States are grouped in reference to their locality, making five separate groups or distinct British Colonial Empires.

	COUNTRIES.	Area Square Miles.	POPULATION.		Value of British produce exported to Foreign States and British Colonies in 1855.			
			Total Amount.	Per Square Mile.	Amount.	Per Head of Population.		
					£	£	s.	d.
1	The United States of America	2,936,166	26,500,000	9·	17,318,086	0	13	1
2	**Anglo-Indian Empire**	**1,391,411**	**173,314,068**	**124·6**	**11,642,445**	**0**	**1**	**4**
3	Hans Towns	....	....	....	8,350,228		....	
4	Turkish Dominions	1,377,358	35,350,000	25·6	6,631,839	0	3	7
5	**Anglo-Australian Empire**	**3,568,000**	**726,993**	**0·2**	**6,278,966**	**8**	**12**	**8**
6	France and her Colonies	381,955	38,438,519	106·6	6,048,409	0	3	4
7	Holland	63,944	13,528,753	41·5	5,115,978	0	7	4
8	**Anglo-American Empire**	**4,147,715**	**3,438,418**	**1·3**	**4,866,895**	**1**	**8**	**3**
9	Brazil	3,956,800	6,065,000	1·5	3,312,728	0	10	11
10	Spain and her Colonies	243,550	17,653,651	72·4	2,783,413	0	3	2
11	Belgium	11,366	4,359,090	383·5	1,707,693	0	7	10
12	**British Mediterranean Possessions**	**1,159**	**388,894**	**335·5**	**2,160,461**	**4**	**5**	**8**
13	Portugal and her Colonies	936,700	5,134,640	5·4	1,484,383	0	5	9
14	Egypt	....	....	....	1,454,371		....	
15	Chili	175,000	1,269,000	7·2	1,330,385	1	1	0
16	Denmark and her Colonies	46,121	2,154,855	46·7	1,327,979	0	12	4
17	Peru	437,120	1,726,350	3·9	1,285,160	0	14	11
18	**British African Empire**	**167,357**	**553,657**	**3·3**	**1,135,530**	**2**	**1**	**2**

Value of British Produce exported in 1855.	COUNTRIES.

		Value of British Produce exported in 1855. Amount.			
		£	COUNTRIES.		
19	Russia	....	19 to 34	Brought forward	9,902,529
20	Prussia	1,100,021	35	Central America	266,191
21	Two Sicilies	921,220	36	Greece	222,460
22	China	888,679	37	Haiti	160,128
23	Sardinia	853,916	38	Papal States	147,013
24	Africa, West Coast	839,831	39	Morocco	133,697
25	Buenos Ayres	742,442	40	Mecklenburgh	64,788
26	Austrian Territories	717,713	41	South Sea Islands	45,860
27	Tuscany	620,307	42	Oldenburg	25,405
28	New Granada	588,935	43	Escuador	8,854
29	Mexico	585,898	44	East Coast of Africa	3,425
30	Sweden	545,384	45	Tunis	2,199
31	Norway	487,400	46	Africa, Red Sea	2,009
32	Venezuela	378,491	Add Heligoland and Channel Islands		468,578
33	Hanover	337,354			
34	Uraquay	294,938		Total £	95,688,085

BRITISH EXPORTS.

1855 to		1856 to		1857 to	
Foreign States.	British Colonies.	Foreign States.	British Colonies.	Foreign States.	British Colonies.
£69,135,210	26,552,875	82,526,509	33,300,489	85,039,990	37,115,247
95,688,085		115,826,948		122,155,237.	
Ratio . . 2·63 to 1.		2·47 to 1.		2·26 to 1.	

APPENDIX No. III.

TABLE compiled from PARLIAMENTARY RETURNS of 15th April, 1852, showing the former STRENGTH of the QUEEN'S and COMPANY'S FORCES in INDIA, and the MILITARY RESOURCES of NATIVE PRINCES, with the ratios of EUROPEAN to NATIVE TROOPS in the several ARMS.

	QUEEN'S TROOPS.	COMPANY'S TROOPS.				Gross Total Queen's, Company's, and Contingent Forces.	Ratio of Queen's and Company's European Troops to Company's Native Troops.	Military Resources of Native Princes.	GROSS TOTAL.		Proximate Ratio of Queen's and Company's European Troops to Company's and Native Princes' Native Troops.
	European.	European.	Natives.	Native Contingents.	TOTAL.				European Troops, Queen's and Company's.	Native Troops, Company's and Native Princes.	
Engineers	...	321	2,248	...	2,569	2,569	1 to 7	...	321	2,248	1 to 7
Artillery	...	7,436	9,004	...	16,440	16,440	1 to 1·2	12,962	7,436	21,966	1 to 3
Cavalry	3,664	469	30,851	8,907	40,227	43,891	1 to 9·5	68,303	4,133	108,061	1 to 26
Infantry.....	25,816	9,648	193,942	27,404	230,994	256,810	1 to 6·2	317,653	35,464	538,999	1 to 15
Medical	Incl. above	1,111	652	...	1,763	1,763	1·7 to 1	...	1,111	652	1·7 to 1
Warrant Officers ..	...	243	...	...	243	243	...	...	243	...	...
Veterans	...	700	3,424	...	4,124	4,124	1 to 4·8	...	700	3,424	1 to 5
TOTAL	29,480	19,928	240,121	36,311	296,360	325,840	1 to 5·59	398,918	49,408	675,350	1 to 13·5

The ratios exhibited in the above Table, between the numbers of Native and European Soldiers in our Indian Army, offer the best index to the source of the Mutinies. It is not surprising that a fanatical but well-trained Army should be stimulated by intriguing leaders to take the management of what they considered their own country out of the hands of a very small minority of military force, whose habits and religion were offensive to their prejudices. The mutineers knew the results contained in the foregoing Table. They knew that they numbered seven Native Sappers to one European Engineer, that they had a preponderance of the Artillery—that they had over nine Cavalry Soldiers to one, and six Infantry Soldiers to one. Who can wonder that leaders like Nana Sahib could rouse such an Army to revolt?

APPENDIX No. IV.

TABLE showing the COMPARATIVE TIME required to concentrate a FIELD FORCE with and without RAILWAYS. The Army is assumed to be stationed in Brigades, each composed of one Regiment European Infantry, one Regiment Native Infantry, one Squadron European Cavalry, one Squadron Native Cavalry, and one Field Battery European Artillery of four Guns and two Howitzers—Brigades placed at equal intervals apart, over a distance of 6,000 miles of main intercourse. The ordinary march 10 miles a-day. Velocity of Railway Trains 20 miles an hour, making Train journeys 480 miles per day of 24 hours, of which one-half is allowed for return Trains, and only one-half for bringing up the Troops. This makes the ratio of marching time to train time in concentration, as 24 to 1.

Aggregate Strength of Army.	Aggregate Annual Cost of Army.	Number of Brigades.	Intervals between Brigades.	Number of days required to concentrate to a centre point a force of											
				10,760 Men.		19,368 Men.		27,976 Men.		36,584 Men.		45,192 Men.		53,800 Men.	
				Marching	Rail.	Marching	Rail.	Marching	Rail.	Marching	Rail.	Marching	Rail.	Marching	Rail.
Men.	£.		Miles.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
325,840	13,776,363	151	40	8	·33	16	·7	24	1	32	1·3	40	1·7	48	2
200,000	9,692,045	93	64	12·8	·53	25·6	1·07	38·4	1·6	51·2	2·13	64	2·7	76·8	3·2
150,000	7,947,045	69	87	17·4	·7	34·8	1·4	52·2	2·2	69·6	2·9	87	3·6	104·4	4·3
100,000	6,202,045	46	130	26	1·08	52	2·17	78	3·2	104	4·3	130	5·4	156	6·5

The above Table shows that a force of 53,800 men could be brought to any given point by Railway from a distributed army of only 100,000 men, costing only £6,202,045 annually, in less than one-seventh of the time required to concentrate, by marching, an equal force from a similarly distributed army of 325,840 men, costing £13,776,363 annually. It shows that 156 days, or over five months, would be required to assemble 53,000 men by marching, the aggregate army being 100,000 men; whilst an equal number could be assembled by railway from the same army in seven days. It shows, therefore, that an army of 100,000 men (one-half being Europeans, including the whole of the Artillery and Engineers), would amply suffice for the military occupation of India WITH RAILWAYS; whilst an army of 325,840 (one-half being Europeans, including Artillery and Engineers), would be barely sufficient WITHOUT RAILWAYS. It shows, in fact, that the smaller army, with Railways, would be sevenfold more efficient than the larger army would be WITHOUT RAILWAYS.

APPENDIX

TABLE showing the COMPOSITION, STRENGTH, and COST of an ARMY of OCCUPATION former MILITARY ESTABLISHMENT. Also the RATIO in which the EXTENSION of strength and cost of the ARMY. Also the GENERAL REVENUE DEFICIENCY and requisite for the safe occupation of the COUNTRY, and as influenced by the extent

	MEANS OF COMMUNICATION.	Ratio of European to Native Troops. European.	Ratio of European to Native Troops. Native.	Aggregate Force.	EUROPEAN TROOPS. Artillery.	Engineer.	Cavalry.	Infantry.	Total.
				Men.					
a Old Establishment which produced Mutiny.	Without Railways	1 to 5½		325,840	7,436	321	4,133	37,518	49,408
b Safe Establishment for Future.	Without Railways	1 to 1		325,840	16,440	2,569	21,945	121,966	162,920
	With 4,000 miles of Railway	1 to 1		200,000	16,440	2,569	16,198	64,793	100,000
	With 6,000 miles of Railway	1 to 1		150,000	16,440	2,569	11,198	44,793	75,000
	With 12,000 miles of Railway	1 to 1		100,000	16,440	2,569	6,198	24,793	50,000
c Hazardous Establishment for Future	Without Railways	1 to 2		325,840	16,440	2,569	13,668	75,937	108,614
	With 4,000 miles of Railway	1 to 2		200,000	16,440	2,569	9,531	38,126	66,666
	With 12,000 miles of Railway	1 to 2		150,000	16,440	2,569	6,198	24,793	50,000

a The first line in the above Table shows the former establishment of our Indian Army, which, by its composition of 5½ Natives to 1 European, with a preponderance of Artillery and Engineers, was well calculated to lead to the Mutiny we are now seeking to suppress. The old establishment is taken from Parliamentary Return 15th April, 1852. The gross cost is the average of 4 years, taken from Parliamentary Return 1855-6.

b The third, fourth, fifth, and sixth lines of the Table show a safe composition in future of an Army for occupying India, in which the ratio of Natives to Europeans is taken as 1 to 1; the

No. V.

for INDIA, as rendered necessary by the late MUTINIES, in comparison with the RAILWAYS in INDIA will admit of reduction being made in the future numerical SURPLUS respectively, as dependent upon the extent of the MILITARY CHARGES of RAILWAY intercourse.

NATIVE TROOPS.					Total Numerical Force.	Total Annual Cost of Force.	Annual Saving by Extension of Railways.	GOVERNMENT FINANCES.	
Artillery.	Engineer.	Cavalry.	Infantry.	Total.				Annual Deficiency of Revenue.	Annual Surplus of Revenue.
						£	£	£	£
9,004	2,248	39,758	225,422	276,432	325,840	10,106,679	...	1,676,333	...
...	...	21,946	140,974	162,920	325,840	13,776,363	...	5,346,017	...
...	...	20,000	80,000	100,000	200,000	9,692,045	4,084,318	1,261,699	...
...	...	15,000	60,000	75,000	150,000	7,947,045	5,829,318	...	483,301
...	...	10,000	40,000	50,000	100,000	6,202,045	7,574,318	...	2,228,301
...	...	29,252	187,974	217,226	325,840	11,923,089	...	3,492,743	...
...	...	26,666	106,668	133,334	200,000	8,583,385	3,339,704	153,039	...
...	...	20,000	80,000	100,000	150,000	7,217,456	4,705,633	...	1,212,890

whole of the Artillery and Engineers being European. These lines show the ultimate saving of Revenue to be effected by Railways as £7,574,318, and that a deficiency of £5,346,017 would thus be converted into a surplus Revenue of £2,228,301.

c The sixth, seventh, and eighth lines give what is termed a hazardous establishment, where the ratio is 2 Natives to 1 European; still, however, reserving the whole Artillery and Engineer arms as European. It is merely added to exhibit a financial comparison, which assuredly does not justify the increased risk.

Evening Meeting.

Monday, March 29th, 1858.

Colonel the Hon. JAMES LINDSAY in the Chair.

The Chairman announced that 21 Members had joined the Institution since the 15th March (see page 35).

ANNUAL SUBSCRIBERS.

Smith, Gerrard, Lieut. Scot. Fus. Grds.
Cunliffe, R. A. ditto, ditto.
Dalzell, R. A. ditto, ditto.
Twyford, H. Capt. 36th Regt.
Field, Jno. W. P. Lieut. Hon. Art. Co.
Finucane, Geo. Col. ret. full pay
Bryans, Jas. W. Lieut. ret. Bom. Army
Greenwood, Jas. Capt. 5th R. Lan. Mil.
Ramsay, T. W. Com.-General
Kidd, Jno. A. Lt.-Col. late 87th Fus.
Twynam, P. A. A. Capt. 15th Regt.
Palmer, Roger, Lieut. 2nd Life Gds.
Owen, Mostyn, Lieut. late Shrop. Mil.
King, John R. Lieut. Royal Artillery
Carey, Constantine P. Lieut. Roy. Eng.
Blair, Stopford, Col. h.-p. Roy. Art.
Ducie, Lord, L.-Lieut. of Gloucestershire
Cunningham, H. D. Paymaster R. Navy
Meade, J. Capt. late 96th Regiment
Worsley, Lord, Capt. Roy. W. Lincoln Mil.
Estridge, Geo. Lieut.-Col. St. Kitts Mil.

INCREASED SUBSCRIPTIONS.

	£	s.		£	s.
Rooke, C. A. Capt. Hon. Art. Co.	1	0	Ducie, Lord, Lord-Lieut. of Gloucestershire	1	0

DONATIONS.

List of Donations from 16th to 29th March.

	£	s.		£	s.
Peel, Jonathan, Major-Gen. Sec. of State for War . . .	5	0	Fox, C. R. Lieut.-Gen. (Life Member)	3	10
Deacon, H. Rear-Admiral .	1	0	Sweny, M. H. Capt. R.N. .	0	10
Nolloth, Edmund, Surgeon R.N.	1	0			

THE LIBRARY.

Books.

(*The Donors' Names in Italics.*)

CUNNINGHAM (H. D. P.) Paymaster R.N. On the Sail Power of Steam Ships. Pamph. 8vo. Portsea, 1857. *The Author.*

FISHBOURNE (E. G.) Captain, R.N. Observations on the Present State of Naval Architecture. Pamph. 8vo. London, 1858. *The Author.*

SYKES (W. H.) Col., M.P. Speech of Colonel Sykes in the House of Commons on Thursday, February 18th, 1858, on the proposed India Bill. Pamph. 8vo. London, 1858. *The Author.*

GEOGRAPHICAL SOCIETY, THE ROYAL (Proceedings of). Vol. II. No. 1. January, 1858. *The Society.*

KENNEDY (C. Clark) Major. The Theory of Musketry adopted for the use of Troops. 12mo. London, 1855. *The Author.*

CARTER (Henry J.) Assistant Surgeon H.E.I.C.S. Geological Papers on Western India. 8vo. Bombay, 1857.

Atlas, ditto. *Col. Sykes, M.P.*

ANSTRUTHER (P.) Col. Madras Artillery. Flight of Projectiles. Pamph. 1858. *The Author.*

LANDT's Feroe Islands. 1 vol. 8vo. London, 1810. *Gen. Fox.*

Plates, &c.

Two Pictures, framed and glazed, of the Pera and England, two vessels fitted with Mr. Cunningham's new sails. *H. D. P. Cunningham, Esq., R.N.*

THE MUSEUM.

Models.

2 Wooden Railway Whistles.
2 Leaden do. do.
1 Rifle Shell.
1 Rifle Ball.
1 Concussion Fuze.

Hollow elongated Rifle Shot adapted to Rifle Cannon, containing its own cartridge of gun-cotton. Whatever acid is left from the explosion of the gun cotton is expended in the hollow of the shot.

Frictional Igniting Appliance for firing Submarine Shells, Ordnance, and Alarm Guns and Signals. *Captain John Norton.*

A Copper Sounding Tube with vanes compressed by the pressure of water at 200 fathoms. *Captain Washington, R.N.*

Case containing the component parts of the Atlantic Telegraph Cable.
The Directors of the Atlantic Telegraph Company.

Case containing his improvements in Cap Primers for sea-service as introduced into the Navy,—Vent-plugs and Cartridges for sea-service Pistols and Revolvers.

1 Sea-service Pistol, rifled. *Captain Montague Hayes, R.N.*

Highly ornamented Paddle from Solomon's Island, South Pacific.
Captain Washington, R.N.

Piedmontese Officer's Sword.

1 Grape Shot } picked up on the field of Waterloo.
1 Bullet }

Captain De la Charmette.

Part of a Russian Telegraph taken by him at Hango, whilst in command of H.M.S. Blenheim. *Captain Hall, R.N., C.B.*

A shot fired from the Hecla under his command into the Fort of Bomarsund, on 21st June, 1854, and found there on the capture of that fort on the 16th August following. *Captain Hall, R.N., C.B.*

Case containing a pair of Lyre Birds. *Sir Charles Wood, Bart.*

ON THE SUBMERGENCE OF THE ATLANTIC TELEGRAPH CABLE.

By Captain M. S. Nolloth, R.N.

Before attempting to occupy your attention for a while, I wish to say that, with one or two obvious exceptions, the following remarks were written a considerable time ago; that is, shortly after reading in the public papers the official account of the failure to submerge the Atlantic Cable, and when there seemed some reason to fear that, from the degree of success attained, no alterations in the old mode of procedure would be made, and no preliminary experiments thought necessary to increase the probabilities of success at the next endeavour.

But it is well known that since that period the promoters of this great and difficult undertaking have been busily engaged in providing the most promising plans for future action, and that, besides the aid of the able gentlemen in their employ, they have sought advice from men eminent for their scientific acquaintance with the nature of the various details upon which success depends. Under these circumstances, I desired to withdraw the few plain remarks which I had been invited to prepare, but was requested to read them as originally intended.

The Report alluded to contains the following passages:

"After leaving Valencia the paying out of the cable progressed most satisfactorily until immediately before the mishap.

"As the water deepened, it was necessary to place some further restraint upon it by applying pressure to the friction-rollers, and this was gradually and cautiously increased from time to time as the speed of the cable compared with that of the ship and the depth of the soundings showed to be necessary."

After deepening from 550 to 1,750 fathoms, "As the water deepened the proportionate speed of the cable advanced, and it was necessary to increase the strain by degrees."

After laying out 255 miles, "Having reached 2,000 fathoms, it was necessary to increase the strain."

Apparently six or seven hours after having reached 2,000 fathoms, "The speed of the cable gained considerably upon that of ship, and while the rate of the latter was about three knots the cable was running out from $5\frac{1}{2}$ to $5\frac{3}{4}$ knots per hour. The strain was then raised." This was not found sufficient to check the cable, "the wind and sea increasing and a current at the same time carrying the cable at an angle with the ship's course." The retarding force was therefore increased; "and then again in consequence of the speed continuing to be more than it would have been prudent to permit. By this the rate of the cable was brought to a little short of five knots, at which it continued steadily until it parted, the length paid out at that time being 380 miles."

While the Report admits that the origin of the accident was undoubtedly the amount of retarding strain, it is asserted that had the machine been properly manipulated at the time it could not possibly have taken place, and that no alteration from the present cable would be advisable if another had to be constructed, "its weight in water being so adjusted to the depth that the strain is within a manageable scope."

With real deference for the judgment of the writer of the above, whose skill and experience in such matters are known, I find it difficult to adopt in its unqualified shape the opinion quoted in the last paragraph, or to admit that "the paying-out of the cable progressed most satisfactorily until immediately before the mishap," as announced in the first. In my humble opinion the facts rather warrant the belief that the specific gravity (about 3·5) of the cable is too great for not only the greatest, but the great depths, and that the restraint necessarily exercised on board to prevent a dangerously accelerated descent, and to maintain a proper relation between the speed of ship and that of cable, afforded, from the entrance upon the deeper and rougher water, a too doubtful prospect of success, considering the great distance to be run.

We see that from the commencement it was necessary to use a retarding force—that with increasing depths additional force had to be applied—and that when at the greatest depth attained—at the threshold of the real work—the demand for cable above that due to the advance of the ship went on increasing till the issue was at

nearly twice the speed of the latter, and additional restraint was applied till shortly before the fracture.

Now, putting aside the probability of meeting worse weather, it can scarcely be concluded that when the cable parted the last demand for additional restraint had been made: but, allowing that it had then reached its maximum, when it is considered that the course lay over a wide and ever-restless ocean—that the connexion was between an advancing ship and several miles of line quitting with its own *proper* motion, ready for dangerous acceleration at any slight relaxation—that the extra strain produced at every check must be in exact proportion to the reduction of momentum effected—it would seem that the life of the enterprise hung at every moment upon a thread, and that it was too much to have expected in so costly an undertaking that the nice manipulation required in such fast and loose play would be applied throughout the run, without one wrong and fatal turn of the wrist.

When 214 sea miles had been run, 255 statute, or 220 sea miles, of cable had issued: according to this the excess of cable over 214 miles run was only the surprisingly small quantity of 2·8 per cent. When the parting took place the ship had advanced about 270 sea miles, and had expended 380 statute or 328 sea miles of cable. Thus 108 miles of line had been expended in running the last 56 miles; so that, supposing the ship to have continued her course, with this degree of waste, till she arrived at the corresponding depth on the opposite side of the Atlantic, she would have required, for more than 1000 miles, an excess of cable nearly equal to the distance run. No doubt a small portion of this waste occurred (although it is not so stated) during the stoppage to readjust the cable on the sheaves; but it is clear that when fairly in very deep water the difficulties were insurmountable, and that it is fortunate that the fracture took place at so early a stage of the proceeding.

The difficulties in such operations increase in a faster ratio than the depth, and this great Atlantic task is of an essentially different character from that of the submergences hitherto effected. The vast distance alone removes it from their category: but here our risks are not only more numerous but of a far more serious nature, and, while the value imperilled is greater, accidents are less

within the reach of remedy. It is difficult to conceive a project upon which the cost of a few decisive experiments would be more economically bestowed.

How many of the submergences hitherto effected, including those in comparatively shallow water, would have added to the list of failures if they had had to stand their trial throughout a run of 1600 miles! The pitcher may be often used at the well, but it will be broken at last.

On reading the Report the question arises,—Which of the two forces was most inimical to the task in hand—gravity or horizontal motion of the water acting against the bight of the descending cable?

Had the gradually increasing call for pressure on the brake, as the ship passed over increasing depths, been caused by the "swigging off" of currents upon a vast bight, this would have been plainly indicated by the line growing out on the quarter, and the waste would not have been confined to so small a quantity, till shortly before the accident, without a restraining force greater than the cable could have possibly borne. But, although we read that fresh demand for cable is the constant coincident of greater depth, we have no allusion to the line being drawn away at an angle with the ship's course till the late period just mentioned, when "the wind and sea increased." There can be little doubt that the reduced speed of the ship, the increasing sea, and increasing weight from depth, suffice to account for the great waste latterly, without the supposition of under-currents. The greater and more irregular the ship's motions the more frequently would the release or relaxation of the brake be required, and at 2,000 fathoms, great strain at any acceleration might be expected independently of any *lateral* force. The oblique direction of the line was most probably owing to the ship being drifted by an upper current. The effect of this would be very different from that of deep currents acting on the bight, and would involve little, if anything, more than the extra expenditure due to deviation from the straight course.

It is clear that, whatever be the forces, the "give-and-take" action when a force is applied above constitutes the direct danger in a seaway, and that the object should be to diminish it by dispensing as far as may be with the *brake* which brings it into play.

The onward motion of even a large ship is not quite equable in a sea, however uniformly applied the propelling power: deep plunges forward, alternate with sudden retardations, and a serious portion of these actions, and of the more vertical ones of the stern at "pitch" and "scend," must now and then be simultaneously resolved, to and fro, in the direction of the outgoing line. The combined effects must be at one moment a virtual relaxation of the brake, and at the next a sudden recall like the "smack" of a whip.

Let any one, when the lead has just reached the bottom in about 100 fathoms, and the line is still descending, stoop down, and suddenly gather up as much as he can at one haul. If new at such work he will be astonished at the great resistance to his recovery of even three or four feet of a light, thin, smooth line, and it will help him to appreciate the strain that must be brought by any sudden attempt at recovery on the upper part of three or four thousand fathoms of running line weighing 15 cwt. in water, independently altogether of friction on a circumference of nearly two inches.

Moreover, it must have been impossible at so great a depth, by observing the angle of exit or otherwise, to make more than a very rude estimate of the form or of the length of line sustained by the retarding agency, and this agency which created the danger, in proportion to the degree in which it was exercised, may (notwithstanding the excess, generally, of cable over distance run) have been *occasionally* the means of supplying its own work, by dragging along a lengthening line. Calculations upon assumed relative speeds, depth of water, and other data, can be only of very partial application where the "constants" must be so *in*constant, but, with a heavy cable requiring severe control by brake, it is clear that we are involved in a dilemma; for while great strain must be caused, even in a calm, by maintaining a small angle of exit in deep water, dangerous relaxations and retardations must result, in a seaway, from *not* maintaining a small angle.

Undoubtedly, if means had been provided of counteracting the reciprocating motions by long spiral springs applied to leading pulleys before the brake, the risks would have been greatly diminished; but I fear that unless we produce a uniformity of brake action, equal to that effected by the air-vessel of a fire-engine,

we can scarcely reckon in a seaway, *throughout a long run*, over great depth, upon a safe adjustment to the capricious requirements of a cable much specifically heavier than the fluid.

Enough, however, was performed in the way of submergence to remove all doubt as to eventual, if not as to immediate, success: and, considering the experience just gained, few who read his Report will blame the persevering Engineer for his sanguine statement that he "sees no reason for discouragement, but has a greater confidence than ever." Recollecting the mishaps in other cases, it cannot be thought very strange if in the first attempt to span the ocean we got rather out of our depth.

But it must be borne in mind that the final object of this great work is not to lay a line across the ocean, but to place upon its bed, in its integrity, an electric conductor, and, as far as possible, so to lay it, that, after escaping fracture or partial damage from heavy jerks in its passage, its *durability* may not be impaired by parts being landed upon hard matter, with long intervening portions quite unsupported, however flexible. We learn from Captain Dayman's soundings that there are rocky and stony regions; and in these considerable irregularities of surface may be expected. Fortunately, we have reason to believe that there is little agitation of the lower waters; but, as the least disturbance might eventually prove fatal if considerable spaces were bridged over, we should not reckon too strongly upon this favourable circumstance, nor rely unduly upon incrustation, remembering that here, as in other cases, the efficiency of the whole line—whether mechanical or electrical—is only that of the weakest section.

The undertaking to span the "bottomless deep" is in itself so surprising that we are liable to be led away from the real idea, and, in the near prospect of such a feat, to lose sight of its being only a means to an end.

It is not improbable that successful submergence would at once prove a great stimulant to similar enterprises, and that the first message across the deep would be a signal for the preparation of other ocean lines, especially if, with its lightning speed, the first should be found too slow of speech. When the great cost of such cables, independently of their submergence, is considered, it would be a great

misfortune if after having been constructed and laid down they should soon lose their vital element—that, having safely reached their beds, they should shortly go to sleep and refuse to make a sign.

Now, if the weight were such that the cable could be generally left to itself, or rather to the buoyancy of the fluid, so that if allowed to do its worst at the greatest depth, it would expend its acceleration without having acquired too great a velocity,—in other words, if the specific gravity were so adjusted to the great depths that the *unrestricted proper motion* of the cable would supply the difference between the distance run and the line of deposition, the great risks in a seaway would disappear, and the great waste now inevitable at slow speed against head winds could be easily avoided.

Experiments at the nearest 2,000 fathoms depth would nearly enough determine the specific gravity which, at the greatest depth to be encountered, would, at a given safe *speed* (upon which the degree of *broadside*, and therefore the *rate of* descent, would depend), allow the supposed requisite per-centage of cable over distance run. A greater excess of line could be issued whenever thought advisable, not by faster descent, but by slightly slower advance of ship, which would not materially alter the angle formed by so light a cable. To provide against the cable issuing, under any circumstances, at a faster rate than that due to the ship's advance—as in the case of a strong head wind and sea—a very simple appliance would suffice to effect the required slight retardation, without ever communicating the dangerous *snatching* motions of the vessel; the reverse or *yielding* motions would not require to be counteracted, as with a heavy cable. A delivery-drum driven by machinery would be required, and the means, as before, of registering the issue.

On the whole, the speed of ship might be, with safety, greater than with a heavier cable, as it would require to be limited only by regard to the relative motion beyond which experience had ascertained that the cable could not be properly worked in the hold.

It is needless to allude to the great advantage of saving time in this undertaking, not only for the avoidance of chances of bad weather, but for the saving of cable from the ship being set out of her course by currents; in the latter economy are involved not

only expense, but the chances of durability, which, in several respects, must be considered as inversely to the length laid down. The more horizontal the descending cable the less must be the waste through the tendency of every portion to overshoot its berth, from the reaction of the water at right angles to the line at the points impinged upon.

A small angle of incidence, which is of so great importance in a seaway, would be preserved by speed of ship and slow descent of cable without a dangerous, especially when intermitting, agency; while, instead of a cable rushing straight away on its release, the lifting stern, or any accidental stoppage in the delivery, would have not only a slight weight but some chance of slack to veer and haul upon.

Thus, neither electric conductor nor its envelope would have efficiency hazarded by jerking motions, while freedom to attend to the ever-varying calls of gravity, without any mischievous interference from above, where judgment as to what is taking place below must be at fault, would conduce to a deposition in conformity not only with the general profile of the ground, but with comparatively trifling irregularities.

But again the question meets us, "Can we reduce the great evil of the vertical without introducing a greater from the horizontal force?"

The report to the Directors deprecates decrease of specific gravity, alleging that "danger would arise from under-currents acting upon an increased surface during the greater time occupied in sinking."

The effect of strong lower currents is no doubt an important element for consideration supposing them to exist; for the "scare" of 2000 fathoms of $\frac{7}{8}$ inch diameter exposed to their action would be 625 square feet; but it seems especially formidable in regard to *tension*, when the "swigging-off" force is brought into play by a strain intermittingly applied at the upper part. Important horizontal movement of the lower waters of the open ocean is not however credited by the best authorities. Wasteful expenditure of line appears most likely to result from the ship being carried out of the direct track by upper currents; and, excepting the case of a current of trifling vertical extent, and the direction and force of which could be ascer-

tained and allowed for, such waste is unavoidable. Supposing only lower important currents, I should think waste from this cause also unavoidable, as not subject to safe control.

Since the above was written I have received a copy of the report of the soundings along the telegraphic plateau by the very experienced officer Captain Dayman, R.N. In some of these Massey's patent *machine* was used with a *marked* line, and the two indications agreed sufficiently at very great depths to show that the line must have been carried down perpendicularly, and that therefore no current had affected it. On one of these occasions the depth registered by machine was 2,176 fathoms, but 2,400 fathoms of line had been paid out to ensure the detachment of the weight. To the surprise of himself and assistants, the 200 fathoms next to the sinker came up to the surface in one entangled coil, covered with the mud of the bottom, leaving only 24 of the 224 fathoms of extra line to be accounted for. Such facts are valuable, also, in giving confidence in ocean sounding, when executed with skill.

If it should unfortunately prove that demand for extra cable is greatly caused by vertically extensive currents sweeping away the bight, we should have to deal with a far less manageable element than *weight*, and I should be little sanguine of speedy success.

When other ocean lines are taken in hand, as they assuredly will be, the following questions will be maturely considered:

Is the wire envelope necessary for the preservation of the heart or conducting wires?

Is it necessary for the sake of rapid descent through important lower currents?

Is it necessary for safe manipulation, bearing in mind that a light cable would not be subjected to the rough usage incident to the existing brake system?

If the present Atlantic cable—which for its strength, extreme pliability, and excellent workmanship throughout has been universally admired—should be hereafter deemed too heavy for the conditions to be fulfilled, in order to diminish as far as possible the probabilities of ultimate mischance, the best expedient would appear to be extraneous buoyancy. In an undertaking on so large a scale, every application of this nature is likely to assume a formidable shape in

regard to expense, convenience of handling, and space for stowage. Perhaps the cheapest practicable measure would be to seize coire rope along the portion intended for the great depths, the seizings being sufficiently close to prevent obstruction from the bights to the clear working of the coils.

Coire is not very much lighter than sea-water, but its buoyant effect would be assisted considerably by its "dragging" action during the oblique descent, and a given quantity of the material thus applied would give a greater area of resistance than if laid up with so as to form part of the cable itself, and without corresponding increase of rigidity.

The cost of 2-inch coire rope is about 5*l.* 6*s.* per mile, and rather less if of foreign manufacture.

It would perhaps be too much to state, as a possible incidental advantage, the chance of the elastic coire saving the end of the cable in the event of fracture.

Whatever be the nature of the cable employed, it would be of the highest importance if some means could be contrived of saving the end in case of accident; but here I am afraid we must say more emphatically than usual "prevention is better than cure," for it would certainly appear from the expedients hitherto proposed that it is difficult to devise a "save-all" which would not greatly add to the chance of total loss.

The least excusable cause of failure would be want of sufficient length of cable; but it is not at all probable that difficulty will arise on this account, the distance to be run on the great circle being 1,646, and the length of cable provided 2,400 miles.

It was originally intended to employ two ships in simultaneously laying down from mid-way to the shores after joining ends. Supposing equal appliances and supervision, this plan would appear greatly preferable to the one adopted, except for the greater probability of clearing the commonly boisterous neighbourhood of Ireland in favourable weather, and unless the latter were viewed as the more cautious one for a first attempt: and, indeed, with the results before us, it is certain that had the ships made a fair start in calm weather, such as would have been chosen, a much greater length of cable would have been irrecoverably lost than is now the case.

A short run of success from mid-way would carry each ship to comparatively safe depth; and at the finest season of the year, when the weather probabilities may be considered equal along the course, the choice of time at mid-way would afford a better security for favourable weather throughout, than that made at one extreme of the line.

We know that the joining of the cables midway in fine weather, when neither would be submerged, would present no difficulty; but the arrival at midway with one cable on the ground at 2,000 fathoms might be fatal, whether the attempt were made or not at the time; and, if successfully made, the critical operation of handing over the strain, from the ship letting go the bight to her colleague, would then have to be performed.

A small stage to float the bight between the vessels while splicing and when preparing to separate might be convenient; and, if made of substances not likely to have their specific levity soon impaired under pressure, it might be advantageously allowed to accompany the bight to the bottom, so as to reduce the rapidity of descent.

It has been objected, that, as two portions of the cable would be worked at the same time, extra risk of losing a great length would be incurred by the chance of fracture at both ships; but it is obvious, that on the plan adopted, one parting necessitates the chance of a second rupture, with irrecoverable loss, in the subsequent under-running.

The probabilities of depositing the cable in hollows would be perhaps greater when generally decreasing than when generally increasing the depth; and it is somewhat in favour of a start from the middle—vast depth being the chief difficulty—that in costly undertakings it is, *cæteris paribus*, better to incur the greatest inevitable risks at as early a stage as possible.

I add a few remarks on some of the various schemes which have been proposed, chiefly in the public papers.

One recommendation is, to use "perforated tin buoys, which would hold the cable after it was paid out, preventing a strain, and gradually as they sank in their order taking it with them to the bottom."

Apart from the fact that the cable seems already too much inclined throughout its course to find its way to the bottom, most practical men will allow that, even if the buoys would behave as intended, and not fill too soon or collapse, this plan is scarcely feasible throughout so great a length. Inflated bags would be preferable to tin buoys, as they would be cheaper, more easily stowed away empty till wanted, more readily attached, more certain of buoyancy when required, and more certain of losing it at a proper time through compression.

"No Engineer" proposed—and surely no sailor will agree with him—to avoid injury from the sudden lifting of the stern, by "linking a number of pontoons together, and then attaching them to the stern of the vessel, so that the weight of the cable being borne by their buoyancy, without disappearing in a calm, the tail of the line of pontoons would, when a sea did come, yield to its weight, and thus prevent a jerk that would otherwise snap the cable."

It certainly would not be safe to subject the cable to such an ordeal of "fair-leaders" in its passage to the deep. In all probability, the being held obliquely to the ship's track, and confused swells thrusting them against each other when doing their best to perform the duty required of them, would, "when a sea did come," at once render it necessary to disencumber the cable of them, or of their remains.

The recommendation to pass the cable through a trunk in the vessel's bottom, near the centre of motion, is an idea which probably occurred to many acquainted with the old method of fitting our launches in the Navy; but the extreme inconvenience of this mode of exit in more than one respect—the fact that the bodily rise and fall of the ship would still have to be met, the concealment of the issuing portion, and the difficulties likely to arise with much rolling motion—seem fatal objections.

It has been proposed to inclose the cable in a gutta-percha tube of rather larger diameter, for the sake of buoyancy, chiefly from the air filling the spaces between the seizings used to secure it.

The cheapest tubing likely to prove water-tight would alone cost 8*d.* or 9*d.* per foot, independently of the expense of enveloping the

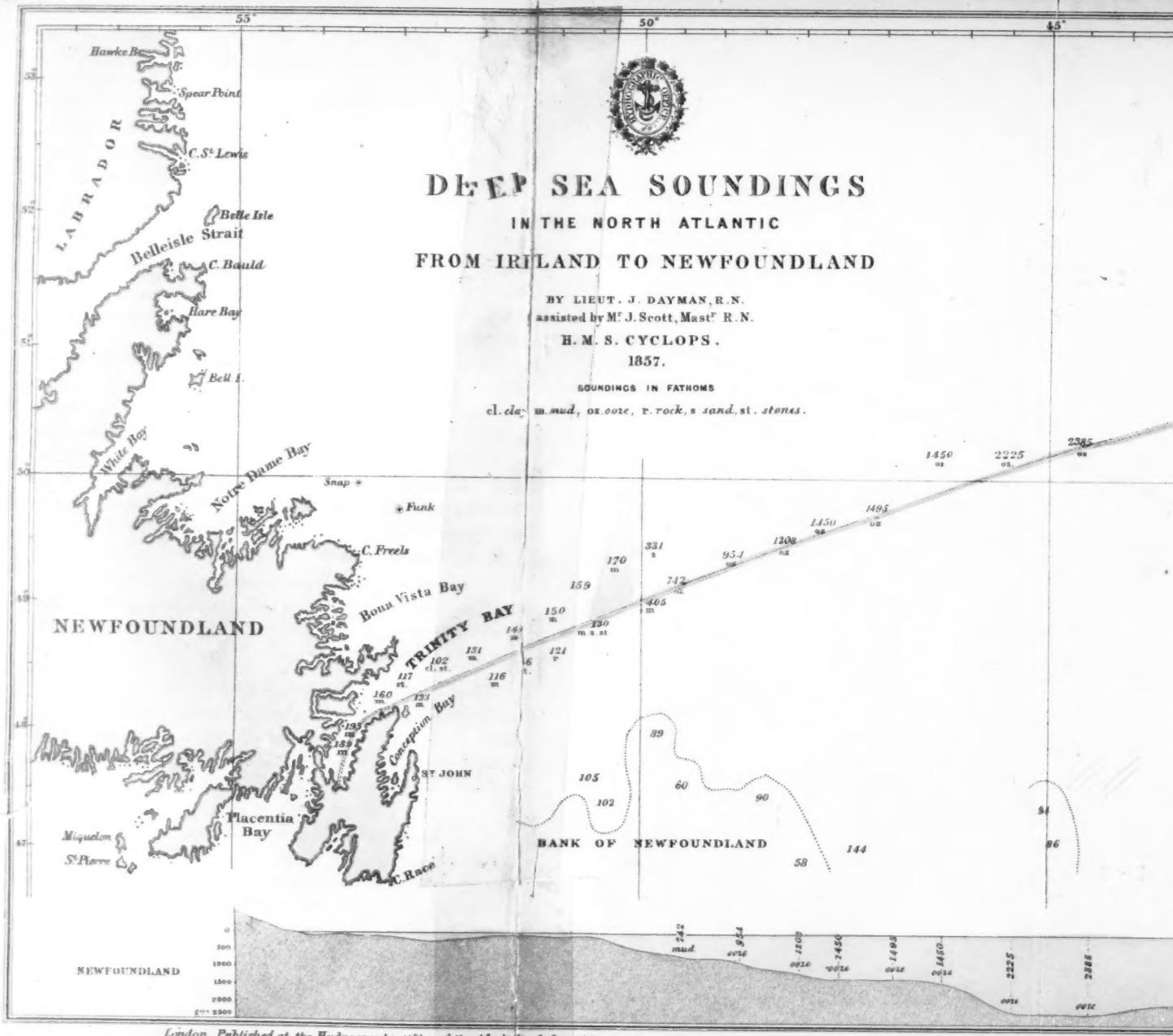
cable, which would not be so simple a process as "drawing" the gutta-percha with the wires; moreover, the contained air—if contained—would lose $\frac{1}{4}$ its buoyancy before it had descended $\frac{1}{140}$ of the way to the greatest depth. This would therefore be a plan for paying heavily for a light advantage.

Perhaps the most curious suggestion called forth by the Atlantic Cable, is the proposal to reeve it through a ring in the bottom of a vessel five miles astern of the principal, so that in the event of fracture the end would be secured by the vessel holding on the bight.

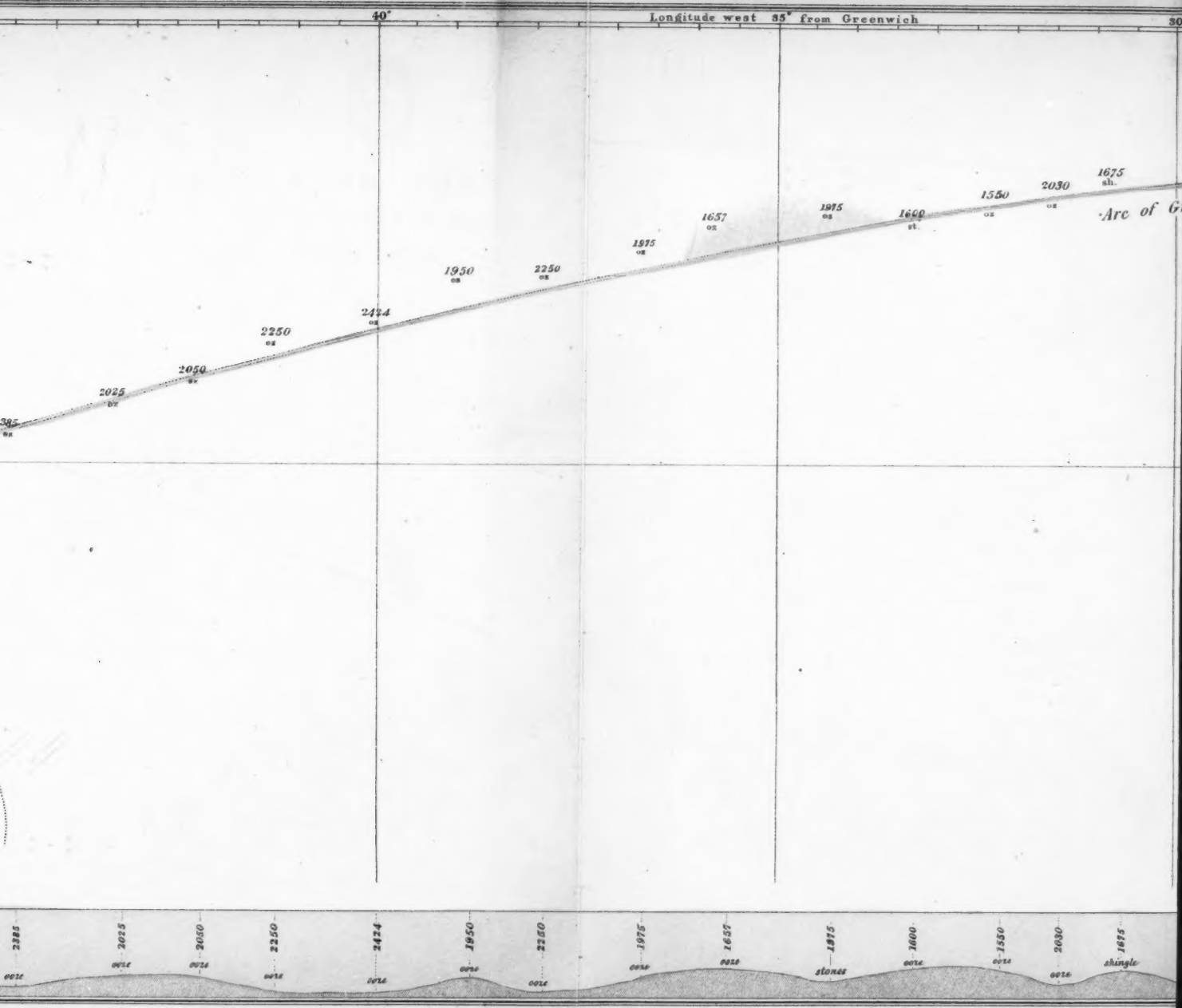
It is true that, as the retarding force of gravity on one side would equal the accelerating force on the other, there would be no possibility of an unduly heavy cable fetching way when once in motion, and either paying itself out too much under foot, or running out to the clinch; but one ship would experience no greater immunity from the waves than the other; and when it is considered that the great difficulty in hand is vast depth—that this would be dealing with it thrice instead of once, that even a short run obliquely to the trend of the cable ahead might be fatal, that the whole cable already safely landed, with portions probably lodged under rock, would have to be raised—this scheme may almost be called, notwithstanding the favourable opinion of the "Times," "A plan for carrying away the cable after successful submergence."

Various other proposals, including "floats" and "stopwaters," have from time to time been made, to ensure the safe deposit of the Atlantic Cable, but few of them show sufficient regard to the important items of cost, convenience of handling, and space for stowage. Solid buoys are too cumbrous for such an undertaking: hollow ones, unless of great strength, involving inconvenient weight, must burst at considerable depth from want of equal pressure within, and yielding substances would permit an equilibrium at the expense of buoyancy. These seem sufficient objections to such appliances, even if they were practicable; but the stage to be anticipated for this great work is a ship on a stormy sea, in a dark night, the ship and cable rapidly parting company.

But, since the above rather popular suggestions were offered and



London, Published at the Hydrographic Office of the Admiralty 1 Dec. 1857.
Sold by J. D. Potter Agent for the Admiralty Charts, 31 Poultry & 11 King Street Tower Hill.



SECTION OF THE BED OF THE ATLANTIC OCEAN FROM VALENCIA TO TRINIT

Vertical Scale 4000 f^ms^ 1 inch Scales as 30 to 1.

25° 20°

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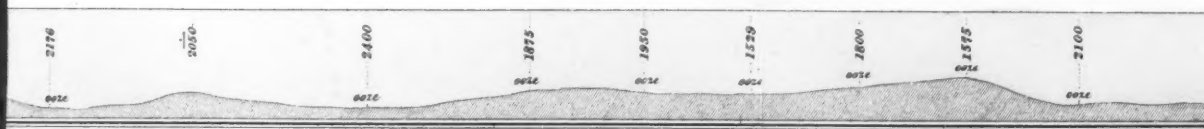
eat Circle between Valencia and Newfoundland



BAY, NEWFOUNDLAND.

Malby & Sons, Lith.

reviewed, the subject has been taken up afresh in earnest, and the Atlantic Telegraph Company have had under their investigation a variety of ingeniously devised schemes for procuring the great desideratum under existing circumstances, viz., a more uniformly acting control over the descent of the cable, so as to meet at the greatest depths the difficulties presented by irregular motion. Moreover, the start will be from mid-way at the finest season of the year, after complete experiments, which it appears circumstances did not permit before, so as to test as thoroughly as may be thought expedient the fitness of the new arrangements.

Under these circumstances, whatever may be the opinions as to weight, we may reasonably believe, and we must all desire, that the skill, anxiety, and public spirit manifested, will meet their reward in the safe launch of this leviathan of the deep. Every one must wish success to the approaching attempt to tie the Old and New World together, and hope that the bond may prove, in the fullest sense of the term, a lasting cord of commerce and civilization.

Before us is a case containing specimens of the component parts of the cable, for which the Institution is indebted to the kindness of the Atlantic Telegraph Company.

Capt. FISHBOURNE, in expressing his entire concurrence in the above views, stated that it was due to Capt. Nolloth that he should say that he had perused Capt. Nolloth's paper before the recent discussions on the subject took place, and had seen the sketch of a plan by him for mitigating the sudden effect of the ship's motions upon the cable, similar in principle to the means which he believed were to be adopted at the next attempt at submergence.

N.B. The United Service Institution is indebted to the Admiralty for the accompanying diagram of the soundings along the Atlantic Telegraph Plateau.

PRACTICAL REMARKS ON A FEW POINTS RELATIVE TO STEAM VESSELS.

By George Biddlecombe, Esq., Master R.N., late "Master of the Fleet" in the Baltic.

I regret that my duties prevent me from treating more fully, at present, the subjects upon which I have been invited by the Lecture Committee of the "United Service Institution" to prepare a paper: but I hope that the few practical remarks which follow will be acceptable, and may tend in some measure to promote the discussion of professional topics.

It is but a few years since steam-vessels were first used for war purposes. About the year 1830, H.M. steam paddle-vessels "Comet" and "Confiance" (now used as tug vessels) were introduced: then followed the "Rhadamanthus," "Salamander," and "Medea," and vessels of a larger class. These vessels were conceived to be easily disabled in action, by shot or shell passing into the engine-room. Many were the attempts made to render their engines invulnerable, but with little or no success: ultimately public attention was drawn to the *screw-propeller*, which, besides fulfilling the required condition, has now rendered the armament of steam-vessels of war so efficient.

Paddle-wheel vessels have advantages for towing, and for river purposes.

First. There is no danger of fouling the wheels in a paddle-vessel should the towing-hawsers part, as the latter would be brought in abaft the wheels; but, with screw propelled vessels, in the event of the hawsers parting they might foul the screw before it could be stopped. No greater proof is wanting than the case of H. M. ship "Exmouth," Rear-Admiral Sir Michael Seymour, when in the Baltic: the sheet cable got round the boss of the screw so securely that it was with great difficulty and delay extricated.

The towing-hawsers should in all cases of screw-vessels be led in through the stern hawse-pipes, to obviate such a disaster as fouling the screw; although I am quite aware that having the ends led in more abeam assists the towing-vessel in turning. One of the most important

points to be attended to, is to increase the speed very gradually, and also to steer the towed vessel into the wake which the towing-vessel has made.

Mr. George Turner, the assistant master shipwright of Keyham Dockyard, has contrived an admirable guard, for the protection of the screw-propeller, not only from shot, but from being fouled by rigging or other matter.

I believe the opinion has nearly become obsolete that a vessel on shore can be readily towed off by a paddle-wheel steamer: it might be successful in cases where the vessel has merely touched the ground, but when she is what is termed *fixed*, no paddle-wheel vessel will remove her until lightened; or an anchor laid out ahead of the towing-vessel, so that the cable may be hove in at the same time that the steam-power is applied, creating a steady tension.

Secondly. In paddle-vessels the movements are more readily controlled, and therefore they are preferable for *river* purposes, for when the engine is stopped, the speed is at once checked, but with the screw, little effect is produced immediately on the way of the vessel. The paddle-vessel stopping her engines reduces the speed almost instantly; and stern, and again head, way can be quickly given; but in screw-vessels these changes are not so speedily made, for some time elapses before the back turn is felt; and in going ahead again some little time is lost. These are points merely referred to as being particularly applicable to river navigation, or intricate, and especially unknown, places. A point requiring a simple remark, although generally known, is the going astern both in paddle-wheel and screw vessels; with all after-sail set, the vessel on going astern brings her stern up to the wind against the helm: then falling off a few points she will again return with her stern to near the former position. I am aware that in calm weather, the helm governs the vessel somewhat; but with the least wind the result will be as above.

A few words may not be out of place in reference to screw-vessels weighing and requiring to turn short round. The helm should be put to the necessary direction *before* moving the engine: this adds very materially to quick turning: another point worthy of particular notice is in reference to the direction in which the screw rotates,

some turning to the right, others to the left: for it is obvious that upon this particular arrangement of the screw, depends the celerity of the vessel turning more readily to starboard or to port, as the descending arm acts against solid water, whilst the ascending one acting upwards cannot meet so great a resistance. This is a point worthy of consideration when anchoring in, or weighing from, a narrow berth.

With regard to *turning*, I may here observe that the steam-ship "Leviathan" will have a great advantage in moving through narrow channels, and turning, from having paddle-wheels, as well as the screw, the former of which can either be used conjointly, or separately, while the screw would be turning her on a pivot, or moving her ahead gradually if necessary, thereby turning her almost in her own length.

In 1847, Her Majesty's ship "Blenheim," an old 72-gun ship, had her poop cut off and a screw-propeller introduced, and Captain Chads was appointed to experimentalize on her. The speed obtained was about five knots per hour; and of such importance was it considered, that the Earl of Auckland, then first lord, with the other members of the Admiralty were on board the flag-ship of the experimental squadron to witness that performance at sea. The successful introduction of a screw to a mere block in form, proved what screw-propellers would do if properly applied.

Her Majesty's ship "Amphion," Captain Williams, and corvettes "Plumper," Commander Nolloth, and "Reynard," Commander Cracroft, of about equal size, were fitted at the same time with screws; the first-named vessel was attended in her experiments by Mr. Smith the inventor of the screw, who with Mr. Dinnen, the inspector of steam machinery, suggested many valuable improvements; and we may consider that from that date screw-propelled vessels have gradually advanced to a state of efficiency scarcely at that time contemplated. The "Plumper" was very successful, producing an excellent result: she was afterwards employed on the coast of Africa, and is at present at Vancouver's Island. The "Reynard" also answered well, but was unfortunately lost in India after navigating many intricate rivers in China.

Paddle-wheel steamers for war purposes, generally, were doomed

from the day of the "Blenheim's" trial at sea. First, because the screw itself being chiefly immersed is greatly protected from shot, and secondly in screw-ships of the line, and large frigates, the engines are below the water-line: consequently nothing but a vertical shot or shell is liable to injure them; added to which, the coal-bunkers, being generally around the engine-room and boilers, afford great protection. Again the armament of the screw-vessel may be a complete broadside, like that of a sailing-vessel, and her superior stability enables her to carry more sail than a paddle-vessel.

About the year 1848 the French government fitted the "Napoleon," a ship of the line, with a screw-propeller and an engine of great power, producing the unprecedented speed under steam (for a line-of-battle ship) of ten or eleven knots per hour; proving that the screw could be introduced most effectively to this class of vessels, and this gave a great impulse to the adoption of the screw as a propeller.

Her Majesty's ships of the line "Sanspareil" and "Agamemnon," the latter of 91 guns, were fitted with screws: the "Agamemnon" answered admirably, astonishing even the most sanguine, and when hostilities commenced with Russia in 1854, we had the "Duke of Wellington" (which had been altered) of 131 guns, obtaining a speed of upwards of ten knots per hour under steam alone, besides several other screw line-of-battle ships, and numerous screw-vessels.

Having elsewhere * explained my views regarding the movements of steam-fleets, I proceed to make a few brief general observations.

Before an engagement, it would generally be desirable to send top-gallant masts on deck and to rig in jib-booms. Also to send all spars, sails, &c. out of the tops, to avoid gear falling on deck, thereby not only endangering men's lives, but interfering with the working of the guns:—besides such risks, the above precaution lessens the chances of gear getting adrift and being drawn into the screw, thereby fouling it, and rendering the vessel with her armament next to useless.

Whatever opinions may be entertained as to the arrangement of a fleet, there cannot be a doubt, that a compact force is the most available for attacking an enemy's fleet; its disposition is therefore a subject of great importance. The opportunities of practising this with steam-fleets has been *nil*—for, notwithstanding a large screw-force

* "Steam-Fleet Tactics." Wilson, 157, Leadenhall Street, London.

was employed in the Russian war both in the Baltic and the Black Sea, other employment required more attention than manœuvring.

One of the first objects I would aim at, is to do away with the old idea of the Commander-in-chief leading a fleet *generally*, because it does not permit him to view the fleet fully; nor can he so readily alter the distribution of it by signal, as it would require to be repeated. Admiral the Honble Sir Robert Stopford took the initiative in this particular at the bombardment of St. Jean d'Acre in 1840: he went on board the steam-vessel "Phœnix," which enabled him to detect the position where support was required, when the "Revenge," Captain Waldegrave, was ordered to the spot, and assisted much in silencing the fire at that angle of the fortress.

The want of an officer of sufficient rank astern, as well as leading, has induced me to make the proposal on this point in my book on "steam tactics:" these officers should be thoroughly conversant with the commander-in-chief's ideas, and have full powers to make signals, which would obviate many mistakes that occur in a fleet; and, from being the vessels first to move, we should have little chance of witnessing what most officers who have served in a fleet doubtless have, confusion from following a vessel which has made a mistake at starting.

With regard to the speed of the fleet, there cannot be a question that it should be that of the slowest vessel, otherwise the fleet would separate: under ordinary circumstances a speed rather slower might be desirable, not only for controlling the movements of the vessels more readily, but with regard to that most important consideration, consumption of fuel.

The going astern should not be resorted to in any movement of the fleet generally, there being no certainty where the vessel may get to: it should therefore only be resorted to, to avoid collision, or under particular cases of manœuvring.

My object has been aimed at commencing evolutions by *porting* the helm, and it is desirable for the sake of uniformity, that it should be carried out when *practicable* in all manœuvres: there necessarily will be cases in which this cannot be practised; these should be notified to the fleet by a particular flag hoisted with the signal for the evolution.

Anchoring, in a fleet, is easily arranged either by anchoring *ahead*

of the leading ship, thereby inverting the line, which is sometimes desirable when going into action, or *astern* of the leading ship, as the line is formed, or in columns similarly: but a very certain manner of forming a good line at a common anchorage would be, previously to form the "line abreast" on the line of bearing in which it is intended the ships should take up their berths: then to proceed very slow until near the anchorage, when the signal with *one* flag should be made to stop and prepare to anchor; when the head-way is reduced, a stern-way should be given, anchoring as the vessel arrives on the bearing. The leading vessel from which you are to anchor in line of bearing should be quick in taking her berth, so that no time may be lost in vessels going too far astern: and to know when the senior officer or leading ship has anchored, the flag which was hoisted to prepare to anchor should be hauled down on the instant, and so on with all the other vessels as they anchor, (taking care to preserve their distance from the senior officer,) which would avoid that objectionable system of anchoring with head-way.

With reference to a steam-fleet, anchoring *in the line of the tide* should if possible be avoided, so that in the event of bad weather and a vessel parting her cable she may not drive into the hawse of her next astern: this disaster would be avoided by the ships anchoring on a line of bearing somewhat *across* the line of tide.

Weighing with a steam-fleet is so simple that it scarcely requires any remarks, steam-power enabling you to do almost any thing. If in a narrow anchorage, where a long vessel would have difficulty in turning, when the tide is slack, shorten in cable to nearly up and down, then secure the cable, putting the helm hard over; then move the screw very slowly, when the vessel may be turned almost in the opposite direction; then stop the engine, weigh the anchor off the ground, and move the screw very slowly to keep the vessel's head in the required direction while heaving up. In calm weather at single anchor, a turn or two of the screw at slack-water would prevent fouling the anchor and would be useful when moored and likely to swing the wrong way: when preparing to unmoor with an elbow in the hawse, if the steam is up the vessel may be turned round to clear it.

In attacking a fleet at anchor, or springing a ship broadside on to a fortress, the usefulness of the screw is obvious.

I shall conclude my remarks by saying, that should they in any way assist in the consideration of the subjects mentioned, or in the slightest degree promote the acquirement of professional knowledge, it will gratify me much.

Captain M. HAYES, R.N., exhibited his improvement in Cap-primers for the Service Rifles, &c., which have been adopted in the navy; also a Primer for Revolvers.

These Primers are of prepared India-rubber, cut into a convenient shape, and pierced with holes, which, from the elasticity of the material, holds the caps firmly, but delivers them freely on the nipple.

A Vent-plug for Sea-service Ordnance, which has also been adopted in the Navy.

His patented Skin-cartridge, which is used entire, and is particularly adapted for revolving or repeating arms, and, in fact, for all breech-loading arms.

Also one of the old Sea-service Pistols, which, having been rifled by Captain Hayes, makes excellent practice up to 200 yards, with his Cartridge attached to the Enfield rifle-ball. Vide trials at Enfield, &c. &c.

Col. LINDSAY said, With regard to the Cap-primer, I think there are very few officers who have served in Canada who will not regard it as a remarkably good invention. The men during winter wear mits; for gloves do not keep their hands warm. I have repeatedly observed there, when regiments have been out exercising, and I also remember during the rebellion in Canada, that their hands were at times useless from cold; and if we had had at that time copper caps, instead of flint and steel, we should have been almost worse off with the new arm than with the old. I can quite conceive, in the hard weather, when the thermometer was sometimes below zero, (unless after a march, when the blood is in rapid circulation,) that the hands of the men would be so benumbed as to make it almost impossible for them to feel for the caps in the pouch. I think that this invention would, in a case of that description, be of great value; at any rate, I think Captain Hayes has done good service by bringing forward his invention, and that we ought to be extremely obliged to him.